

**Descriptions of eighteen new species in the genus *Granulina*  
Jousseume, 1888 (Gastropoda: Cystiscidae)  
from the Caribbean Sea**

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Tony McCleery

"Mantaray", Bascombe Road, Churston Ferrers, Brixham, Devon TQ5 0JJ, England

tonymcc\_75@hotmail.com

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**ABSTRACT.** A list of all described Caribbean species in the genus *Granulina* is given. Eighteen new species of *Granulina* from the southern Caribbean Sea are described for the first time, four from eastern Panama: *G. colonensis*, *G. darienensis*, *G. ocella*, *G. waltergoezi*; five from Colombia: *G. cartagenaensis*, *G. gayracaensis*, *G. granatensis*, *G. pinguisa*, *G. velaensis*; six from Venezuela: *G. calla*, *G. iridisa*, *G. monjesensis*, *G. nivalis*, *G. ovata*, *G. volcana*; one from Aruba: *G. plagula*; one from Curaçao: *G. producera* and one from Trinidad and Tobago: *G. tobagoensis*. Biodiversity and features of the genus are discussed and previously undescribed features are presented.

## INTRODUCTION

The genus *Granulina* Jousseume, 1888, has a world-wide distribution in tropical and subtropical seas. Most commonly found in littoral and sub littoral depths, it has also been recorded from abyssal depths down to 1,285 m, with a single record at 1,700 m (Covert and Covert, 1995: 74).

Caribbean Sea is used herein to include south eastern U.S.A. south of Georgia and Bahamas in the north, Trinidad and Tobago in the south east.

In some Cystiscidae genera Caribbean species do not compare well with the type species – the genera *Persicula* and *Gibberula* are examples. The genus *Granulina* appears to be reasonably homogeneous and all described *Granulina* species known to the author compare well with the type species *Granulina isseli* (G. & H. Nevill, 1875), from the Red Sea coast of Egypt. Size range for the genus is given as 0.8-3.2 mm (Covert and Covert, 1995: 73). Caribbean *Granulina* collected by the author range from 1.2 - 3.42 mm.

A total of approximately 75 species of *Granulina* have been described, the majority from north west Africa and the Mediterranean (approximately 35 species). This is followed by the Pacific and Indian Oceans (approximately 20 species), and the Caribbean Sea with only twelve species described to date. These figures fail to indicate the true diversity of this genus; more probably they reflect the historical, low level of interest in micro-molluscs, including families Cystiscidae and Marginellidae. This article will deal with eighteen new species of *Granulina* from the southern Caribbean Sea, where there appears to be a very large number of, as yet, undescribed species. Preceding the year 2000 only seven recognised Caribbean *Granulina* species had been described: *G. agger* (Watson, 1886), W Indies, off Culebra, 714 m.

*Granulina amianta* (Dall, 1889), USA, North Carolina, 26-95 m.

*Granulina antillensis* (de Jong and Coomans, 1988), Aruba and Curaçao, 50 m.

*Granulina hadria* (Dall, 1889), U.S.A., Florida, Cedar Hill, shallow.

*Granulina lachrimula* (Gould, 1862), USA, Georgia and Florida, 260-732 m.

*Granulina ovuliformis* (d'Orbigny, 1842), Gulf of Mexico and Caribbean, moderately deep water.

*Granulina tinolia* (Dall, 1927), USA, north east Florida and Georgia, 538 m.

Since then five more species have been described, all by Espinosa and Ortea, (2000, 2003, 2005), bringing the present total to twelve:

*Granulina aidae* Espinosa & Ortea, 2005, Cuba, Pinar del Rio, 25-30 m.

*Granulina guanajatabey* Espinosa & Ortea, 2003, Cuba, Pinar del Rio, 1-2 m.

*Granulina lazaro* Espinosa & Ortea, 2005, Cuba, Pinar del Rio, 25-30 m.

*Granulina minae* Espinosa & Ortea, 2000, Costa Rica, Manzanilla, 12-15 m.

*Granulina molinai* Espinosa & Ortea, 2005, Cuba, Pinar del Rio, 25-30 m.

The eighteen new species described herein were collected by the author during the past six years. Five were collected in shallow water down to 10 m on and around dead coral rocks and rubble, eleven by dredging in depths between 18 m and 130 m on sand and mud substrates. The genus was found to be well represented in all areas sampled at these depths. Undescribed *Granulina* continued to be found regularly indicating that there are probably many more species remaining to be discovered. Of the eighteen, fourteen are known only from the type locality. Geographic ranges of the remaining four are small.



Map. 1. Caribbean Sea, type localities of the new species

#### Key to map location numbers

1. Panama, off Colon, to east,  $9^{\circ}31.5'N$ ,  $79^{\circ}52.0'W$ , 57 m.
2. Panama, off Isla Chichime, San Blas,  $9^{\circ}37.3'N$ ,  $78^{\circ}53.2'W$ , 75 m.
3. Panama, East Holandes Cays, San Blas,  $9^{\circ}35'N$ ,  $078^{\circ}40'W$ , 3 m.
4. Colombia, off Cartagena,  $10^{\circ}22.4'N$ ,  $75^{\circ}35.8'W$ , 25-41 m.
5. Colombia, Gayraca Bay, Santa Martha,  $11^{\circ}19.5'N$ ,  $74^{\circ}06.3'W$ , 7 m.
6. Colombia, off Santa Martha,  $11^{\circ}18.0'N$ ,  $74^{\circ}12.2'W$ , 90-101 m.
7. Colombia, off Cabo de Vela,  $11^{\circ}57'N$ ,  $72^{\circ}36'W$ , 58 m.
8. Colombia, off Cabo de Vela,  $12^{\circ}06.7'N$ ,  $72^{\circ}19.3'W$ , 50-59 m.

9. Venezuela, Monjes del Sur, harbour,  $12^{\circ}21.5'N$ ,  $70^{\circ}54.1'W$ , 3-10 m.
10. Aruba, Boca Grandi,  $12^{\circ}27.3'N$ ,  $59^{\circ}52.6'W$ , 1-2 m.
11. Curaçao, off Piscadera Bay,  $12^{\circ}07.5'N$ ,  $68^{\circ}58.5'W$ , 130 m.
12. Venezuela, Las Aves de Sotavento,  $12^{\circ}01.66'N$ ,  $067^{\circ}38.05'W$ , 1 m.
13. Venezuela, Cabo Codera,  $10^{\circ}35.2'N$ ,  $66^{\circ}03.9'W$ , 18 m.
14. Venezuela, off Isla Cubagua, to north,  $10^{\circ}52.4'N$ ,  $64^{\circ}12.4'W$ , 22 m.
15. Venezuela, Isla Grande, Islas Los Testigos,  $11^{\circ}22.8'N$ ,  $63^{\circ}08.1'W$ , 28 m.
16. Venezuela, off Islas Los Testigos, to north,  $11^{\circ}28'N$ ,  $63^{\circ}06'W$ , 73 m.
17. Trinidad and Tobago, off Tobago, to north,  $11^{\circ}16'N$ ,  $60^{\circ}49'W$ , 86 m.

**Terminology.** The author has, in general, followed terminology established by Coovert and Coovert (1995). The terms “siphonal notch” and “posterior notch” have precise meanings and are clearly described (Coovert and Coovert, 1995: 50). “Siphonal canal” (Coovert and Coovert, 1995: 47), and posterior canal are used by the author, but do not indicate the

presence or absence of a notch which is a separate and distinct feature.

**Shell morphology.** Shell shape of Caribbean *Granulina* ranges between globose, pyriform and perfectly oval. All are colourless but vary slightly in opacity; are generally, heavily callused; have strongly

denticulate, curved, strongly curled in lip; four, generally strong, columellar plications, almost always excavated and intricately formed distally in a wide variety of distinct shapes. All have immersed spire, medium to very strong external varix extending around posterior and siphonal canals, and most have a parietal callus ridge extending posteriorly from the columellar plications to meet a lumpy posterior ridge. All have Type 2 animal (Coovert and Coovert, 1995: 73), and Type 4 radulae (Coovert and Coovert, 1995: 56).

Surfaces are minutely textured in a wide variety of forms, generally finest on light callus wash extending over the body whorl, and strongest on the callus around the siphonal and posterior canals (Figs 109-132). Callus on body whorls is not well attached and very easily removed by light abrasion, confirming that it is indeed a wash and not micro-sculpture (Figs 139-141). When callus wash is removed faint growth lines are often exposed (Fig. 141). In dead collected shells callus wash on the body whorl was generally found to be absent due to abrasion.

It is well known that some *Granulina* spp. have textured surfaces: *Granulina fernandesi* Boyer & Rolán 1999, and *G. aidae* Espinosa & Ortea, 2005, are examples of shells with unusually strong texture for the genus. Boyer and Rolán (1999: 1-10) state "This feature is however unique and constant in each species, and well representative of the whole genus, even the type species *G. isseli* which represents itself a faint "leopard patterned" microsculpture on a smooth ground". Species which appear to be smooth and shiny to the human eye were previously believed to be without texture, but recent S.E.M. work by the author confirms that probably all *Granulina* exhibit some degree of texture. It was observed that the form of texture is variable over the surface. For example, in *Granulina colonensis* n. sp., surface of the posterior canal is evenly covered by scales, but callus on the body whorl, adjacent to the lumpy ridge bordering the posterior canal is, at first, comprised of distinct round, evenly sized granules, changing abruptly into less regularly shaped and very variably sized granules (Figs 110-112). The body whorl of *Granulina nivalis* n. sp. was found to be lightly textured internally (Figs 136-138). It is not known if this feature is widespread as only this species has been examined so far. It seems probable that surface texture will be useful in species identification but first, more research is necessary in order to establish the degree of both intra-population and inter-population variation which exists.

*Granulina* have partially resorbed internal whorls which Coovert and Coovert (1995: 73) termed "modified cystiscid internal whorls". A drawing presented by Coovert and Coovert (1995: 49, fig. 4), and their description: "columella with 2 internally reduced columellar plications, plus one or two pseudo-continuous plications" (Coovert and Coovert, 1995: 73) is somewhat confusing and is at variance with the author's findings. An explanation for this may be that

Coovert and Coovert illustrated internal plications of *G. hadria* (Dall, 1889), on which species they carried out a very thorough study. Therefore, it seems probable that *G. hadria* differs from many other Caribbean *Granulina* in this respect. Doubt about the accuracy of Coovert and Coovert's conclusions was expressed by Boyer and Rolán (2004: 162), who suggested that Coovert and Coovert had incorrectly interpreted their drawing. They stated that *Granulina* have fully developed coiling of the internal columellar plications, but this is clearly contrary to Coovert and Coovert's findings. Recent work by the author on a number of Caribbean *Granulina* sp. revealed that three plications remain, possibly somewhat reduced, for approximately one turn internally, and can frequently be detected through the body whorl in fresh dead shells (Fig. 55). A number of shells of *Granulina tobagoensis* n. sp. were opened to expose internal whorls and columellar plications (Figs 133-135). It was found that a high degree of resorption had occurred, that resorption was complete posteriorly, and that the plications were much reduced. It can be seen in these examples that resorption is complete posteriorly (Figs 133) and in an early stage anteriorly where the columella remains strong. One juvenile was examined (Fig 135) and resorption was noted to be at an advanced stage posteriorly. Therefore, it is concluded that resorption commences early in the life of the animal of *G. tobagoensis*. The sample was small and much work remains to be carried out, but these preliminary findings support those of Coovert and Coovert.

The shell morphology within the genus *Granulina* is very variable and it is no surprise to find variations in the precise way internal resorption takes place. The important point in this matter is that significant resorption and reduction of columellar plications do take place in *Granulina* species. Partial resorption of internal whorls with reduced columellar plications is the key feature to be considered in family assignment of all marginelliform genera (Coovert and Coovert, 1995: 43).

**Animal chromatism.** In *Granulina* external animal morphology and chromatism exhibit more features than are seen in other Cystiscidae. Some of these features have not previously been documented. For example, the extreme distal elongation of the metapodium (Figs 12-13), and the posterior papillae in some species (Figs 5, 12, 35). On occasions, when photographing live animals an apparently rounded metapodium was observed to gradually extend and become long, thin and very finely elongate distally (Figs 12-13). Occasionally the distal portion is transparent and unmarked and can be very difficult to observe (Fig. 14). Mantles are often only partially visible, seldom being seen fully extended, and are very variable: surfaces can be smooth, pustulose, and occasionally bear long, plume-like posterior papillae which are located on a thick, cap-like area, posterior

medially (Figs 16-17). These papillae were observed to extend and retract rapidly; approximately one second to fully extend to a length which equated with shell length, and a similar time to fully retract. It seems likely that elements which inflate papillae are located in the cap-like area. The number of papillae varies from one to five (Figs 12, 21, 35). Pustules also extend and retract, but were never observed to do so as rapidly as the papillae (See "Remarks" under description of *Granulina cartagenaensis* n. sp.). When magnified, the mantle chromatism was observed to be comprised of extremely small spots amongst more prominent features (Figs 30-32). A common feature of shallow water, rock dwelling species is large ocellated spots, most noticeable when the mantle is extended (Fig. 31). Ocellated spots were not observed on species dredged in deep water from mud or sand substrates. Marks on the metapodium and tentacles, when magnified to around X50, were observed, in live animals, to be three dimensional and to be comprised of many minute irregularly shaped marks, apparently floating within the semi-transparent membrane at different levels and not on the surface. As a metapodium is extended it becomes thinner and the marks which at first may appear to be of solid colour, become stretched and often quite diffuse (Figs 33-34). Iridescent marks are found on the foot of some *Granulina* (Fig. 20). These were first observed in live animals collected by dredging off the mountainous, north western coast of Venezuela where the substrate included a noticeable proportion of gravel containing quartz and pyrites which sparkled when magnified in strong light. It seems possible that the presence of these iridescent markings is an adaptive feature. However, similar iridescent marks were subsequently found in another *Granulina* species (Figs 28-29) in the extensive area of muddy substrates to south and west of Isla Margarita, Venezuela, where there was no evidence of any gravel particles. This contradicts the hypothesis and leaves the matter open to further study.

Melanism was noted to be very common in some *Granulina* species. For example, in *Granulina monjesensis* from the harbour, Monjes del Sur, Venezuela (Fig. 25), and *G. ocella* from East Holandes Cays, San Blas, Panama (Fig. 32), where approximately half the samples collected were melanistic. Many other species collected in the southern Caribbean showed no sign of melanism. In this respect, the genus *Granulina* and the genus *Gibberula* are very similar.

**Identification of species.** This has been based on shell morphology, and animal morphology and chromatism when live animals were available. Several radulae were extracted, and were noted to be Type 4 (Coovert and Coovert, 1995: 56), typical of the genus *Granulina*, but the number examined was considered too small to be useful for species assessment. Some features of shell morphology are dependent on the age of the animal, being weak or absent in young adults

and often becoming very strong in shells of old animals. For example, in *Granulina*, the callus around the posterior canal, and to a lesser extent around the siphonal canal, appears to continue to grow throughout the life of the animal, whereas growth of labial denticles and columellar plications appears to slow down or stabilise. It was observed that old shells have a lower W:L ratio than young adult shells. The reason is that callus growth at both ends of maturing shells increases shell length more than width.

It appears that the intricate and complicated emergent parts of columellar plications are associated with the parietal callus ridge (Figs 92-102) because, lumps and kinks which occur, particularly on the second and third plication, are located on the projected line of the parietal ridge, and also because excavation of columellar plications is aligned with the inner edge of the ridge. They are very constant within each species and are useful at specific level.

The morphology of the foot is problematical and of little use for specific assessment because of difficulty in determining when a metapodium is fully extended. It was noticed that there was a tendency for the individuals in live sample groups to behave similarly when being photographed. For example, if one specimen in a group was observed to have a rounded metapodium, then all specimens in that group tended to show the same state, but on other occasions some individuals of the same species might behave differently. Sometimes mantles were not visible and on other occasions they were fully extended. It is believed that these inconsistencies may reflect the degree of traumatism suffered by the animals during collecting and sorting, the time delay before photographing took place or the water conditions in the aquarium. There were incidents when one or more individuals in such a group would extend its metapodium to become very elongated and thin distally. This made it impossible to accurately assess foot length unless it was extended to be very long and narrow distally – definitely the fully extended state. From these observations it follows that all Caribbean *Granulina* may be able to extend the metapodium to a very elongate state, but more work on live animals is necessary in order to resolve this matter.

With the large number of features to consider *Granulina* species are often relatively easy to identify by shell morphology alone. They are certainly more easily identified than shells of *Gibberula* species in which there are fewer variables and in which it is often essential to examine both shell and animal in order to achieve accurate specific assessment (McCleery, 2008, 2009). However, for example, in this article *G. monjesensis*, *G. ocella*, and *G. plagula* would not have been described as separate new species without observation of animal chromatism. Morphological variations alone between shells of these three new species would not have been considered sufficiently different for positive separation. Now that it has been clearly demonstrated

that they are distinct species, largely due to differences in animal chromatism, the true importance of very small differences in their shell morphology can be recognized.

**Discussion.** Differences in shell morphology between *Granulina* species collected in shallow rocky or reef areas and those dredged in muddy substrates are significant. Shells from the former habitat tend to be small, and have more rounded ends (Figs 61-69), whereas, those dredged from deeper, muddy habitats are frequently larger, very heavily callused, and slightly produced at both ends (Figs 40-45).

Shells of *Granulina* spp. are normally semi-transparent when fresh, but tend to gradually become translucent white when dried. Dead collected shells are frequently opaque, and occasionally extremely hyaline, particularly when collected in fine mud – probably long-dead shells.

As was found to be the case in the genus *Gibberula* Swainson, 1840 (McCleery, 2008, 2009), *Granulina* species also appear to form species groups with wide geographical ranges. For example, *G. producera* n. sp. from Curaçao appears to be closely related to *G. molinai* Espinosa and Ortea, 2005, from Cuba, and the author has in his collection several other undescribed species belonging to this group, represented by only one shell, from widely separated locations. It is expected that many species within such species groups will be found to have small geographic ranges and to be endemic to their type localities. No attempt has been made herein to appraise the various groupings within the genus *Granulina*.

## MATERIAL and METHODS

Hand dredging in sand or muddy substrates and the use of a hand operated suction pump on rocks and rubble substrates were the most productive methods of collecting *Granulina* in shallow waters down to approximately 30 metres. Night diving yielded some positive results as specimens could be picked up from sand and rubble, or off rocks. Many species were collected by dredging from the author's yacht with the aid of a small hydraulically operated reel. The resultant grit from all methods of collection was screened into four grades. The finer screenings were placed in bowls of sea water and covered. Live animals then crawled up the sides where they could be picked up. The finer grades of grit from deep dredging were also sorted visually for dead shells, which comprised an average of approximately 95 percent of all shells collected by dredging. As dredging techniques improved so did the percentage of species containing live animals. Before collecting ceased, approximately half of all species collected by dredging contained live material, probably due to the dredges skimming the surface of substrates rather than by biting too deeply and becoming blocked – much dead material appears to lie in the solid, settled mud, but

live animals inhabit the surface layer and loose algal material on top of the solid mud.

Samples from live material were photographed in a small aquarium below a microscope with a digital camera mounted on top. The same equipment was used for detailed imaging of dried shells and was calibrated so that shell dimensions could be obtained from data displayed by the software. Dimensions of shells are accurate to plus or minus 2 %, and those of live animals to plus or minus 4%. All relevant data, including a chosen shell image were entered in a database. One special feature of the database is a comparator which enables a simple and very effective means for comparing two or more shell images. This proved to be very useful in highlighting small morphological differences.

Shell images are presented at X25 magnification, giving a true impression of relative sizes. Animal images are presented at various magnifications in the range 10X to 20X and images of plications (Figs 91-108) at a uniform image size of 5 cm which equates with approximately X50 to X140 depending on shell length. A number of S.E.M. images of surface texture are presented at various magnifications and have integral scale bar.

## Abbreviations

MNH: Muséum national d'Histoire naturelle, Paris.

AWC: Andrew Wakefield Collection.

TMC: Tony McCleery Collection.

ad.: adult specimen.

juv.: juvenile specimen.

lv.: live collected.

dd.: dead collected.

L.: shell length.

W.: shell width.

## SYSTEMATICS

Family **CYSTISCIDAE** Stimpson, 1865.

Subfamily **GRANULININAE** Covert and Covert, 1995.

Genus *Granulina* Jousseaume, 1888.

Type species: *Marginella pygmaea* Issel, 1869 (non *Marginella pygmaea* G. B. Sowerby II, 1846), = *Marginella isseli* G. & H. Nevill, 1875 (nom. nov.).

### *Granulina volcana* n. sp.

Figs 1-2, 5-6, 37-39, 91

**Type material.** Off Islas Los Testigos, to north, Venezuela, 11°28'N, 63°06'W, 73 m.

Holotype. 2.67 x 1.87 mm, W:L 70%, MNHN 21985; paratype 1. 2.67 x 1.88 mm, W:L 70%, MNHN 21986; paratype 2. 2.70 x 1.88 mm, W:L 70%, AWC; paratype 3. 2.73 x 1.94 mm, W:L 71%, AWC; paratype 4. 2.83 x 1.98 mm, W:L 70%, TMC; paratype 5. 2.44 x 1.61 mm, W:L 66%, TMC.

**Other material.** 2 ad. lv., 2 juv. lv., a number of broken pieces, off Islas Los Testigos, to north, Venezuela, 11°28'N, 63°06'W, 73 m, TMC.

**Type locality.** Off Islas Los Testigos, to north, Venezuela, 11°28'N, 63°06'W (Map ref. 16).

**Description.** Shell without colour, obovate, tending to pyriform. Size range 2.44 x 1.61 mm to 2.83 x 1.98 mm, W:L 66-71%. Body whorl translucent white, weak striations close to external varix, covered by almost smooth, very light callus wash. Lip strongly and evenly curved, curled inwards, evenly wide, moderately strong. Fourteen denticles almost fill inner edge, widely spaced posteriorly. In side view, lip evenly convex. External varix wide, widest and raised on dorsum medially, narrowest anteriorly, sweeps around posterior canal spreading slightly over dorsum, highest above insertion point, forms lumpy ridge ventrally, merges with parietal callus ridge. Weakening varix sweeps around anterior canal, merges with anterior callus, labial edge merges with raised first columellar plication. Four plications fill approximately one third of aperture. First moderately deep, narrow. Second strongest, strongly kinked, merges with anterior callus. Third strong, short, rounded lump distally. Fourth weakest, smaller rounded lump distally. Weak parietal ridge commences at distal end of fourth plication, extends posteriorly and merges with posterior, lumpy ridge. All plications excavated, particularly second and third. Aperture moderately and uniformly wide. Surface of all callus deposits textured with minute pustules.

Animal: Length of fully extended foot unknown, width approximately same as shell, semi-transparent with several small off-white marks laterally, increasing in size posteriorly. Largest mark substantial, white, level with posterior end of shell. Small off-white marks on metapodium concentrated medially form distinct medial line, adjacent bright red lines formed by contiguous red spots anteriorly, reducing in density and fading out distally, further small, scattered, off-white spots extend to lateral edges. Propodium off-white, formed by many small marks which fade out distally. Semi-transparent tentacles, long, thin with three irregularly spaced marks. Black eyes located on basal swellings. Siphon moderately long, thin, semi-transparent with many small off-white spots, distinctive orange-red edges basally. Mantle not observed fully extended. Small swellings visible laterally, therefore, believed to be pustulose. Small areas of colours can also be detected: off-white, yellowish brown, reddish brown, turquoise, and black. Five simple papillae grouped posterior medially on mantle. Mantle roof chromatism appears diffuse through translucent white dorsum,

substantially off-white with some darker areas. Approximately twelve short, yellowish, elongate marks on darker patch can be detected emerging from under anterior dorsal callus, fanning out posteriorly. Almost horizontal, narrow, transverse whitish band located posteriorly.

**Distribution.** Only known from the type locality.

**Remarks.** *Granulina volcana* n. sp. is closest to *G. calla* n. sp. with which it is compared. These two closely related species were collected from localities about seven miles apart. The type locality of *Granulina volcana*, 73 m, is subject to the very strong, westward flowing Equatorial current which enters the Caribbean between Trinidad and Tobago, and Grenada, whereas, the type locality of *G. calla*, 28 m, is close to Isla Grandi, Los Testigos islands, and considerably sheltered from strong currents. *Granulina volcana* is consistently lightly callused, the varix weakens and sweeps around posterior canal, the posterior ridge is smooth, whereas *G. calla* is consistently very heavily callused, has very strong callus at the apex, the varix retains a strong profile fully around the posterior canal, and the posterior ridge is relatively long and lumpy. Chromatism also distinguishes between these two species: *G. volcana* has two strong red lines on the metapodium, a siphon with distinct orange-red edges and no white marks (Figs 2, 5), whereas, *G. calla* has random red spots on the metapodium, the siphon with three white spots basally, no orange-red colouring (Figs 4, 7). The differences described in the shell morphology between these two species were consistent in all mature adult shells examined.

**Etymology.** The name was inspired by the impression of an erupting volcano given by the chromatism of metapodium and its posterior papillae. Latin for volcano is *volcanus*.

***Granulina calla* n. sp.**

Figs 3-4, 7, 40-42, 92

**Type material.** Isla Grande, Islas Los Testigos, Venezuela, 11°22.8'N, 63°08.1'W, 28 m.

Holotype. 2.57 x 1.75 mm, ad. lv., W:L 68%, MNHN 21954; paratype 1. 2.69 x 1.90 mm, W:L 70%, MNHN 21955; paratype 2. 2.64 x 1.82 mm, W:L 69%, AWC; paratype 3. 2.62 x 1.80 mm, W:L 69%, AWC; paratype 4. 2.65 x 1.84 mm, W:L 70%, TMC; paratype 5. 2.53 x 1.74 mm, W:L 69%, TMC.

**Other material.** 2 ad. lv., 1 juv. lv., 4 ad. dd., Isla Grande, Islas Los Testigos, Venezuela, 11°22.8'N, 63°08.1'W, TMC.

**Type locality.** Isla Grande, Islas Los Testigos, Venezuela, 11°22.8'N, 63°08.1'W (Map ref. 15).

**Description.** Shell without colour, obovate, posterior slightly produced. Size range 2.53 x 1.74 mm to 2.69 x 1.90 mm, W:L 68-70%. Body whorl semi-transparent, some very weak irregularly spaced striations, covered by very light callus wash, finely textured with minute pustules. Lip evenly curved, curled inwards strongly, wide, widest medially. Fourteen somewhat irregular denticles fill inner edge, closely spaced anteriorly, wider medially, more so posteriorly. In side view, lip slightly convex. Very strong external varix, slightly raised on dorsum medially, sweeps very strongly around posterior canal, stops abruptly ventrally, forms very strong, lumpy, callus ridge, merges with weak parietal callus ridge. Varix, remaining wide, sweeps around siphonal canal, merges with small area of anterior callus and raised first columellar plication. Four strong plications fill approximately one third of aperture. First moderately deep, narrow. Second strongest, strongly kinked as it emerges, merges with moderately heavy anterior callus. Third strong, short, pointed lump distally. Fourth weakest, smaller pointed lump distally. Weak, even, parietal ridge extends posteriorly from second plication, merges with posterior ridge. All plications excavated, second and third strongly, fourth almost completely. Surface of all callus deposits, including lip and space between plications, textured with minute pustules approximately three times larger than those covering dorsum. Aperture, evenly and moderately wide.

Animal: Length of fully extended foot unknown, width approximately same as shell, semi-transparent with several off-white marks laterally. Random smaller white marks on metapodium form indistinct medial line extending distally. Adjacent to line, on each side, approximately fifteen small, deep red spots intermingled with off-white ones. Further small, off-white spots extend from red spots to lateral edges. Propodium largely off-white with some minute red, brown and white marks. Semi-transparent tentacles, long, thin with five or six irregularly spaced, off-white marks. Black eyes located on basal swellings. Siphon moderately long, thin for genus. Three or four diffuse white spots at base, fine off-white spots intermingled with fewer reddish brown spots, becoming numerous distally. Mantle not observed extended. Small swellings visible laterally, therefore, believed to be pustulose. Small areas of colours also detected – off-white, yellowish brown, reddish brown, turquoise, and black. Five simple papillae grouped posterior medially on mantle (Fig. 7). These were observed to extend and retract rapidly, independently of mantle and each other. Mantle roof chromatism visible through translucent dorsum, substantially off-white with numerous darker areas bearing small yellowish marks and occasional dull reddish spots. Approximately eight short, yellow, elongate marks on darker patch emerge from under anterior dorsal callus and fan out posteriorly. Towards posterior, narrow transverse whitish band slopes downwards to right at about 10°

off horizontal. A few minute irregular black marks which appear to be attached internally to mantle roof can be detected.

**Distribution.** Only known from the type locality.

**Remarks.** *Granulina calla* n. sp. is closest to *G. volcana* n. sp. with which it is compared. These two closely related species were collected from localities about seven miles apart. The type locality of *G. volcana*, 73 m, is subject to the very strong, westward flowing Equatorial current which enters the Caribbean between Trinidad and Tobago, and Grenada, whereas, the type locality of *G. calla*, 28 m, is close to Isla Grandi, Los Testigos islands, and is considerably sheltered from strong currents. *G. volcana* is consistently lightly callused and has a smooth posterior callus ridge, whereas *G. calla* is consistently very heavily callused with very strong callus at apex, the external varix retains a strong profile fully around the posterior canal, and has a relatively long and lumpy posterior ridge. Chromatism also distinguishes between these two species: *G. volcana* has two strong red medial lines on the metapodium, a siphon with distinct orange-red edges and no white marks (Figs 2, 5), whereas, *G. calla* has random red spots on the metapodium, the siphon with three white spots basally and no orange-red colouring (Figs 4, 7). Differences described in shell morphology between these two species was consistent in all mature adult shells examined.

**Etymology.** The name refers to the heavy callus and strong knobby deposits. The Latin for callus is *callum*.

***Granulina colouensis* n. sp.**

Figs 8-9, 43-45, 93, 109-112

**Type material.** Off Colon, to east, Panama, 9°31.5'N, 79°52.0'W, 57 m.

Holotype. 1.98 x 1.31 mm, W:L 66%, MNHN 21958; paratype 1. 1.96 x 1.35 mm, W:L 69%, MNHN 21959; paratype 2. 1.95 x 1.27 mm, W:L 65%, AWC; paratype 3. 2.00 x 1.35 mm, W:L 67%, AWC; paratype 4. 1.76 x 1.20 mm, W:L 68%, TMC; paratype 5. 1.96 x 1.33 mm, W:L 68%, TMC.

**Type locality.** Off Colon, to east, Panama, 9°31.5'N, 79°52.0'W, 57 m (Map ref. 1).

**Description.** Shell without colour, obovate, slightly biconic. Size range 1.76 x 1.20 mm to 2.00 x 1.35 mm, W:L 65-69%. Body whorl semi-transparent, light callus wash, slightly textured. Lip evenly curved, curled inwards slightly, moderately narrow, widest medially, completely filled by twenty two denticles. In side view, lip convex. External varix very strong, wide, slightly wider posterior medially, not raised on dorsum, retains profile and sweeps around posterior

canal with little apparent shoulder, stops abruptly at aperture, very strong, wide, lumpy, callus ridge continues anteriorly, merges with parietal callus ridge. Varix, remaining wide, sweeps around anterior canal, weakening, merges into anterior callus, labial edge merges with slightly raised first columellar plication. Four plications fill approximately 30% of aperture. First sinuous, slightly raised. Second, third and fourth plication discontinuous due to very deep parietal excavation. Distal portion of second stepped downwards at distinct medial lump, extends onto anterior callus with wide axial dimension, widely rounded distally. Distal portions of third and fourth combine in substantial vertical ridge with fine distal end turned outwards onto anterior callus. Posterior end weakens and merges with weak parietal ridge. Inner portion of fourth plication, located on parietal wall deep inside aperture. Aperture moderately and uniformly wide. Surfaces generally lightly textured: callused surfaces with scales and ridges, adjoining body whorl with random sized, roundish lumps (Figs 110-112).

Animal: Length of fully extended foot more than twice length of shell, width approximately same as shell, semi-transparent. Small off-white marks intermingled with many smaller reddish brown spots laterally. Metapodium finely elongate distally. Solid, wide, off-white, medial line extends posteriorly, approximately one third length of metapodium, widening and becoming less solid medially, weakening and fading distally. Weak marks between medial line and edge of metapodium diffuse, off-white, comprised of many small spots. Marks reduce in size posteriorly, intermingle with smaller off-white and reddish brown spots. Edges of metapodium, except distally, highlighted by small, solid, off-white, dashes, generally separated by reddish brown spots. Off-white spots densely concentrated on propodium, particularly close to head. Semi-transparent tentacles, long, thin, rust coloured over whole length with diffuse off-white marks, strongest distally. Eyes black. Siphon and mantle not observed fully extended. Siphon with concentrated small off-white spots. Mantle: poorly observed. Cap-like posterior, suggestive of papillae bears one strong pustule medially (Fig. 9). Mantle roof chromatism substantially off-white with some pale orange spots.

Short, pale, whitish, transverse band located posterior medially, sloping slightly downwards to right.

**Distribution.** Only known from the type locality.

**Remarks.** *Granulina colonensis* n. sp. appears to be most closely related to *G. darienensis* n. sp. (Figs 46-48) with which it is compared. The shell of *G. colonensis* is heavier and more biconic in shape, the lip wider, the varix stronger, posterior and siphonal canals are less flared (Fig. 110) than *G. darienensis* (Fig. 118). The first plication not thickened medially as in *G. darienensis* (Fig. 94). Body whorl surface is textured with small round granules of various sizes (Figs 110-112), but covered by an even scaly texture in *G. darienensis* (Figs 118-120). Chromatism has much in common between the two species, but the strong off-white medial line on the metapodium of *G. colonensis* (Figs 8-9), is absent in *G. darienensis* (Figs 10-11). Pale annular rings highlight the eyes of *G. darienensis* but are absent in *G. colonensis*. These two new species are separated geographically by approximately seventy miles.

**Etymology.** Colon city is located at the Caribbean end of the Panama canal. *Granulina colonensis* was collected a few miles to the east and takes its name from the city of Colon.

***Granulina darienensis* n. sp.**

Figs 10-11, 46-48, 94, 117-120

**Type material.** Off Isla Chichime, San Blas, Panama, 9°37.3'N, 78°53.2'W, 75 m.

Holotype. 2.14 x 1.39 mm, W:L 65%, MNHN 21960; paratype 1. 1.99 x 1.34 mm, W:L 67%, MNHN 21961; paratype 2. 1.88 x 1.30 mm, W:L 69%, AWC; paratype 3. 2.17 x 1.37 mm, W:L 63%, AWC; paratype 4. 2.02 x 1.31 mm, W:L 65%, TMC; paratype 5. 2.06 x 1.36 mm, W:L 66%, TMC.

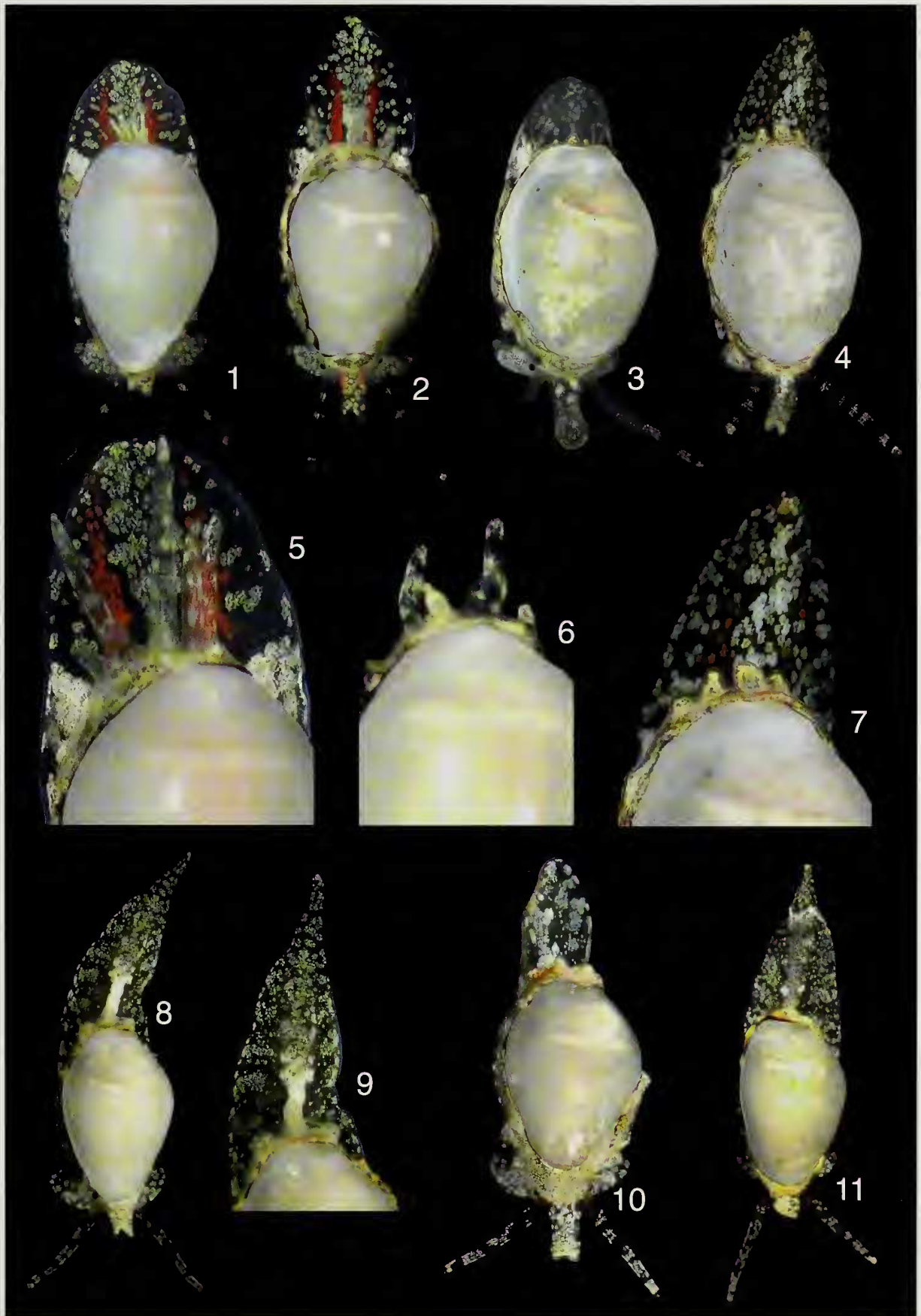
**Other material.** 16 ad. dd., off Isla Chichime, San Blas, Panama, 9°37.3'N, 78°52.4'W, 75 m; 7 ad. dd., off Isla Linton, Panama, 9°31.5'N, 79°52.0'W, 64 m, TMC.

**Type locality.** Off Isla Chichime, San Blas, Panama, 9°37.3'N, 78°52.4'W (Map ref. 2).

**Figures 1-11**

- 1-2, 5-6. *Granulina volcana* n. sp. Off Islas Los Testigos, to north, Venezuela, 11°28'N, 63°06'W, 73 m. 1. Holotype. 2.67 x 1.87 mm, W:L 70%, MNHN 21985; 2. Young adult spm. 2.71 x 1.86 mm, W:L 69%, TMC; 5. Young adult spm. 2.49 x 1.76 mm, W:L 71%, TMC; 6. Young adult spm. 2.68 x 1.86 mm, W:L 69%, TMC. 3-4, 7. *Granulina calla* n. sp. Isla Grande, Islas Los Testigos, Venezuela, 11°22.8'N, 63°08.1'W, 28 m. 3. Holotype. 2.57 x 1.75 mm, W:L 68%, MNHN 21954; 4, 7. Paratype 5. 2.53 x 1.74 mm, W:L 69%, TMC. 8-9. *Granulina Colonensis* n. sp. Holotype. Off Colon, to east, Panama, 9°31.5'N, 79°52.0'W, 57 m. 1.98 x 1.31 mm, W:L 66%, MNHN 21958. 10-11. *Granulina darienensis* n. sp. Off Isla Chichime, San Blas, Panama, 9°37.3'N, 78°53.2'W, 75 m; 10. Holotype. 2.14 x 1.39 mm, W:L 65%, MNHN 21960; 11. Adult spm. 2.19 x 1.41, W:L 64%, TMC.





**Description.** Shell without colour, obovate. Size range 1.88 x 1.30 mm to 2.17 x 1.37 mm, W:L 63-69%. Body whorl translucent white with light callus wash, lightly textured. Lip evenly curved, curls inwards slightly, narrow, twenty three irregular, weak denticles almost fill inner edge, fading out slightly above anterior canal. In side view, lip convex. External varix strong, moderately wide, widest medially, weakens, sweeps round slightly flared posterior canal, fades out over immersed spire. Callus remains wide, develops lumpy external edge ventrally, merges with very weak parietal callus ridge. Posterior callus extends slightly over dorsum. Weakening varix sweeps around slightly flared siphonal canal, merges with anterior callus. Labial edge of weakening varix, merges with slightly raised first columellar plication. Four plications fill approximately 30% of aperture. First strong with significant lump medially. Second, strong with large, pointed lump as it emerges from deep excavation, thins distally, fades out on anterior callus. Third and fourth plications discontinuous due to a very deep parietal excavation. Emergent portion of third, strong and curved, anterior part continues outwards, stops before anterior callus, medial portion continues posteriorly, merges with very weak parietal ridge. Fourth located deep inside aperture. Aperture moderately and uniformly wide. Surfaces lightly textured with random sized scales (Figs 118-120).

Animal: Length of fully extended foot approximately twice length of shell, width approximately same as shell, semi-transparent. Lateral marks not observed. Metapodium pointed distally, variety of shapes and sizes of marks give variegated effect in shades from white to yellowish-white, intermingled with rust brown spots. Concentration of marks shows as faint medial line. Propodium with small off-white spots intermingled with some smaller rust spots. Semi-transparent tentacles, long, thin, with moderately heavy off-white marks, intermingled with some rust marks, distinct rust coloured areas basally, black eyes with off-white annular rings on slight swellings. Siphon moderately long, thick, semi-transparent with many small off-white spots and two small rust spots. Mantle: papillae not observed, but may be present, otherwise weakly pustulose. Chromatism with fine

yellowish-white and rust spots, larger marks intermingled with fine black spots. Mantle roof chromatism substantially yellowish-white with pale orange spots and some darker areas. Approximately six indistinct, short, whitish, elongate marks on darker patch emerge from under anterior dorsal callus, fanning out posteriorly. Pale whitish, transverse band located posteriorly, slopes slightly downwards to right.

**Distribution.** Known from the type locality and off Isla Linton, Panama.

**Remarks.** *Granulina darienensis* n. sp. is closest to *G. colonensis* n. sp. with which it is compared. *G. darienensis* has a somewhat lighter, more rounded shell, narrower lip, weaker varix around siphonal canal, and posterior and siphonal canals considerably more flared than in *G. colonensis*. The first plication bears a medial lump which is absent in *G. colonensis*. The body whorl surface is covered by an even scaly texture (Figs 118-120), whereas, in *G. colonensis* the body whorl is textured with small round granules of various sizes (Figs 110-112). Chromatism has much in common between the two species, but the strong off-white medial line on the metapodium of *G. colonensis* is absent in *G. darienensis*. The eyes of *G. darienensis* are highlighted by pale annular rings, but absent in *G. colonensis*. These two new species are separated geographically by approximately seventy miles.

**Etymology.** This species is named after the mountains of Darien which form the backdrop to the archipelago of San Blas.

***Granulina gayracaensis* n. sp.**

Figs 12-15, 49-51, 95

**Type material.** Gayraca Bay, Santa Martha, Colombia, 11°19.5'N, 74°06.3'W, 7 m.

Holotype. 1.75 x 1.22 mm, W:L 70%, MNHN 21962; paratype 1. 1.61 x 1.08 mm, W:L 67%, MNHN 21963; paratype 2. 1.92 x 1.29 mm, W:L 67%, AWC; paratype 3. 1.64 x 1.17 mm, W:L 71%, AWC; paratype 4. 1.82 x 1.26 mm, W:L 69%, TMC; paratype 5. 1.76 x 1.23 mm, W:L 70%, TMC.

**Figures 12-23**

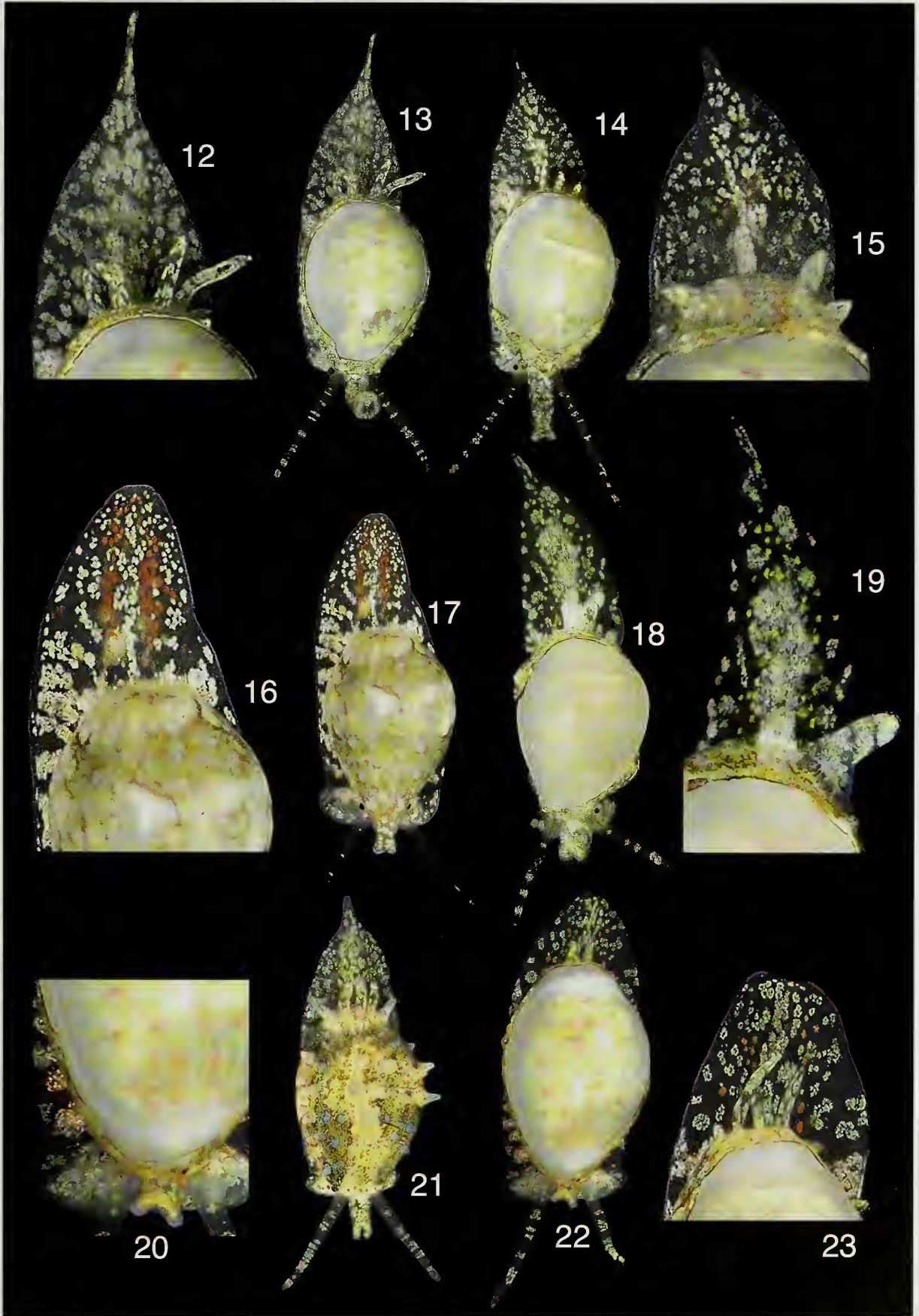
**12-15.** *Granulina gayracaensis* n. sp. Gayraca Bay, Santa Martha, Colombia, 11°19.5'N, 74°06.3'W, 7 m;

**12-13.** Paratype 1. 1.61 x 1.08 mm, W:L 67%, MNHN 21963; **14.** Holotype. 1.75 x 1.22 mm, W:L 70%, MNHN 21962; **15.** Paratype 5. 1.76 x 1.23 mm, W:L 70%, TMC.

**16-17.** *Granulina cartagenaensis* n. sp. Off Cartagena, Colombia, 10°22.4'N, 75°35.8'W, 25-41 m. Paratype 5. 2.20 x 1.63 mm, W:L 74%, TMC.

**18-19.** *Granulina waltergomezi* n. sp. Off Isla Chichime, San Blas Archipelago, Panama, 9°37.3'N, 78°53.2'W, 75-95 m. Holotype. 1.47 x 1.16 mm, W:L 79%, MNHN 21989.

**20-23.** *Granulina iridisa* n. sp. Cabo Codera, Venezuela, 10°35.2'N, 66°03.9'W, 18 m; **20, 22-23.** Holotype. 2.37 x 1.66 mm, W:L 70%, MNHN 21967; **21.** Adult spm. 2.46 x 1.67 mm. W:L 68%.



**Other material.** 21 ad. lv., 18 ad. dd., Gayraca Bay, Santa Martha, Colombia, 11°19.5'N, 74°06.3'W, 7 m, TMC.

**Type locality.** Gayraca Bay, Santa Martha, Colombia, 11°19.5'N, 74°06.3'W (Map ref. 5).

**Description.** Shell without colour, oval. Size range 1.61 x 1.08 mm to 1.92 x 1.29 mm, W:L 67-71%. Body whorl semi-transparent, with textured callus wash. Lip evenly curved, curls inwards, wide, widest medially, sixteen irregular, weak denticles almost fill inner edge, weakest anteriorly. In side view lip mainly straight, turns sharply to right posteriorly. External varix strong, very wide, widest medially, raised on dorsum, sweeps around narrow posterior canal, weakening, forms distinct, lumpy callus ridge ventrally, merges with parietal callus ridge. Weakening varix sweeps around wide, rounded anterior canal, merges with first columellar plication and weak anterior callus. Four columellar plications fill approximately 46% of aperture. First weak, small lump on posterior side, medially. Second wide, strongly kinked as it emerges, fades out and merges with anterior callus distally. Third, weak, distal lump with short finger pointing to anterior callus. Fourth weakest with small raised lump distally. Weak, broken parietal callus ridge commences above second plication, irregularly thick. Aperture moderately wide, widens evenly, becoming wide anteriorly. Surfaces of all callus deposits textured with minute pustules.

Animal: Length of fully extended foot slightly less than twice length of shell, width slightly less than shell, semi-transparent lateral marks only partially observed. Metapodium finely elongate distally, pinkish lateral mark almost level with posterior end of shell, believed to have iridescent properties. Smaller irregularly shaped, off-white marks, intermingled with

smaller rust and minute black spots posteriorly, concentrated medially forming weak line. Propodium with off-white and pale bluish-grey spots and marks and larger, pale pinkish mark. Semi-transparent tentacles very long, thin, with numerous off-white marks intermingled with some rust marks, distinct rust coloured area basally. Black eyes with off-white annular rings on slight swellings. Siphon long and thick, semi-transparent, many small off-white and rust spots, whiter posteriorly. Mantle: not observed extended, weakly pustulose. Chromatism: generally fine off-white, yellowish-white, rust, pale blue, and black spots and marks. Small pustules with turquoise and white tips. Group of five thin, transparent papillae, posterior medially, densely covered with off-white marks, extended length not observed. Mantle roof: Substantially yellowish-white or pale grey, orange spots and some darker areas. Approximately six indistinct, short, whitish, elongate marks on darker patch emerge from under anterior dorsal callus and fan out posteriorly, pale transverse band located towards posterior, sloping slightly downwards to right, thinly edged with grey posteriorly.

**Distribution.** Only known from the type locality.

**Remarks.** *Granulina gayracaensis* n. sp. is closest to *G. ovata* n. sp. with which it is compared. *G. gayracaensis* has a perfectly oval shell, with the widest point located medially, and the W:L 67-71%. *G. ovata*, also a small species, has slightly higher widest point, is less inflated at W:L 64-67%, has a more rounded apex and a more pointed anterior. The most significant difference is the group of five well developed posterior papillae in *G. gayracaensis* which is absent on *G. ovata*. *Granulina gayracaensis* was hand dredged in black sand at 7 m.

**Etymology.** The name is taken from the type locality.

## Figures 24-36

**24-26.** *Granulina monjesensis* n. sp. Harbour, Monjes del Sur, Venezuela, 12°21.5'N, 70°54.1'W, 3-10 m.

**24.** Paratype 3. 1.75 x 1.24 mm, W:L 71%, AWC; **25.** Holotype. 1.74 x 1.27 mm, W:L 73%, MNHN 21969; **26.** Paratype 1. 1.68 x 1.20 mm, W:L 71%, MNHN 21970.

**27.** *Granulina plagula* n. sp. Paratype 1. Boca Grandi, Aruba, 12°27.3'N, 59°52.6'W, 1-2 m. 1.80 x 1.20 mm, W:L 67%, MNHN 21980.

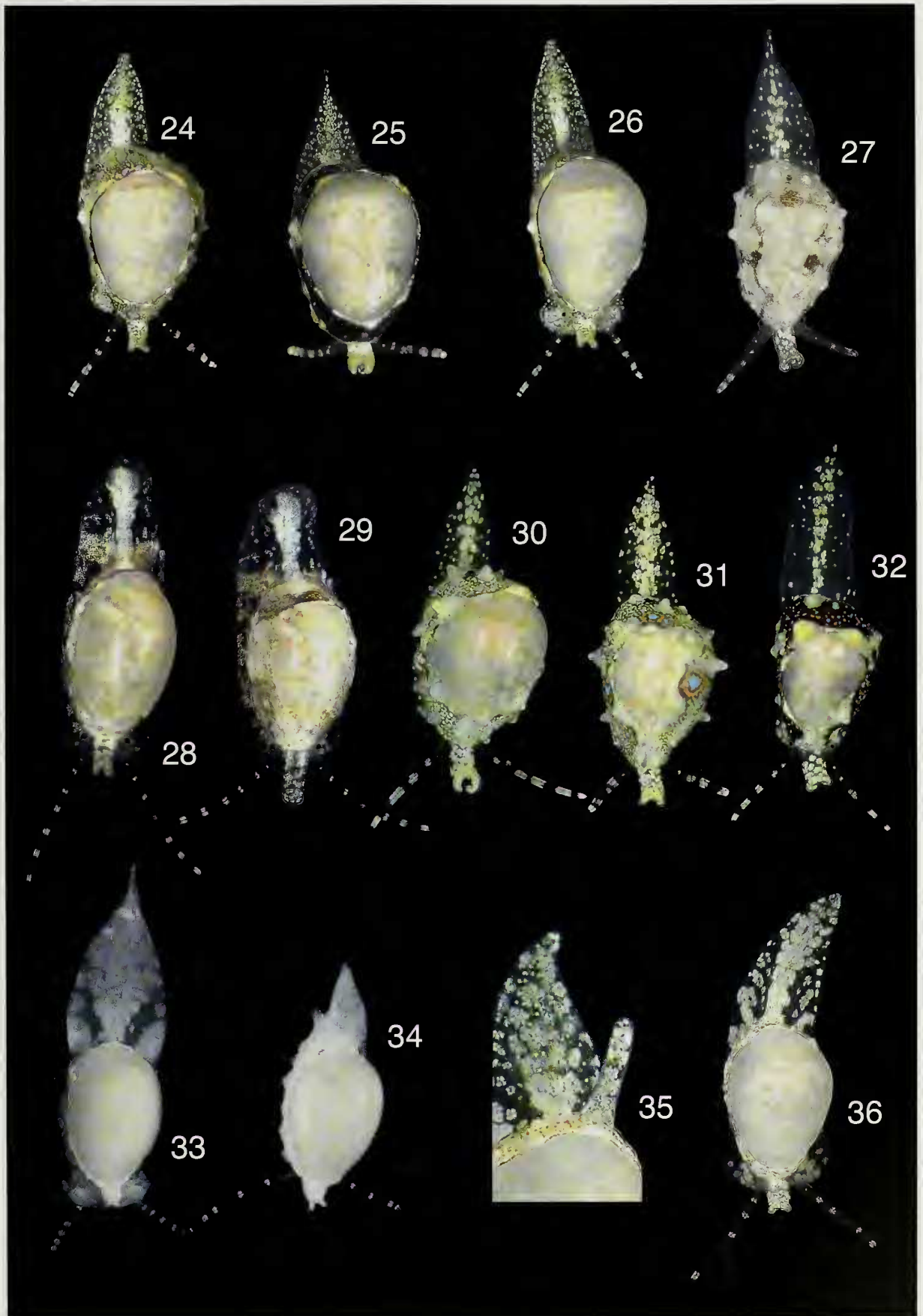
**28-29.** *Granulina ovata* n. sp. Off Isla Cubagua, to north, Venezuela, 10°52.4'N, 64°12.4'W, 22 m; **28.** Holotype. 1.95 x 1.30 mm, W:L 67%, MNHN 21977; **29.** Paratype 1. 2.16 x 1.41 mm, W:L 65%, MNHN 21978.

**30-32.** *Granulina ocella* n. sp. East Holandes Cays, San Blas, Panama, 9°35'N, 078°40'W, 3 m; **30.** Holotype. 1.52 x 1.12 mm, W:L 74%, MNHN 21973; **31.** Paratype 1. 1.56 x 1.14 mm, W:L 73%, MNHN 21974; **32.** Paratype 2. 1.53 x 1.10 mm, W:L 72%, AWC.

**33-34.** *Granulina nivalis* n. sp. Las Aves de Sotavento, Venezuela, 12°01.66'N, 067°38.05'W, 1 m;

**33.** Holotype. 1.62 x 1.15 mm, W:L 71%, MNHN 21971; **34.** Adult spm. 1.73 x 1.27 mm, W:L 74%.

**35-36.** *Granulina waltergomezi* n. sp. Adult spm. from colony at East Holandes Cays, San Blas, Panama, 9°35'N, 078°40'W, 15-20 m, 1.54 x 1.17 mm, W:L 76%.



***Granulina cartagenaensis* n. sp.**

Figs 16-17, 55-57, 96

**Type material.** Off Cartagena, Colombia, 10°22.4'N, 75°35.8'W, 25-41 m.

Holotype. 2.33 x 1.77 mm, W:L 76%, MNHN 21956; paratype 1. 2.56 x 1.90 mm, W:L 74%, MNHN 21957; paratype 2. 2.74 x 2.05 mm, W:L 75%, AWC; paratype 3. 2.65 x 1.96 mm, W:L 74%, AWC; paratype 4. 2.49 x 1.83 mm, W:L 74%, TMC; paratype 5. 2.20 x 1.63 mm, W:L 74%, TMC.

**Other material.** 1 ad. dd., 7 juv. dd., off Cartagena, Colombia, 10°22.4'N, 75°35.8'W, 25-41 m, mud, TMC.

**Type locality.** Off Cartagena, Colombia, 10°22.4'N, 75°35.8'W (Map ref. 4).

**Description.** Shell without colour, almost globose, posterior very slightly produced. Size range 2.20 x 1.63 mm to 2.74 x 2.05 mm, W:L 74-76%. Body whorl semi-transparent, covered by very thin, lightly textured callus wash. Lip evenly curved, curls inwards, wide, widest medially, narrower with slight concavity posteriorly, slightly flared anteriorly. Fourteen denticles, more widely spaced posteriorly, fill inner edge. In side view, lip straight. External varix strong, wide, wider medially, raised on dorsum. Varix, retaining profile with strong dorsal edge, sweeps around posterior canal, ends abruptly at aperture. Dorsal edge sweeps around as strong ridge, develops into strong lumpy callus ridge ventrally, merges with parietal callus ridge. Callus spreads anteriorly from dorsal edge of varix onto dorsum with moderately well defined margin, fades out ventrally. Varix, weakening somewhat, sweeps around anterior canal, spreads onto dorsum with moderately well defined margin, labial edge merges with slightly raised first columellar plication, dorsal edge continues onto anterior callus as rounded ridge aligned with second plication, fades out at distal end of second plication. Four plications fill approximately one third of aperture, all excavated and without significant kinks. First moderately weak. Second slightly thickened medially, long and pointed distally. Third weak, short, weak lump distally. Fourth weaker, short,

very weak lump distally. Anterior callus strong, quickly weakens to light wash at third plication, extends posteriorly as parietal ridge, moderately strong medially. Aperture wide, uniformly wide over entire length. Callus deposits and lip lightly textured with minute pustules.

**Animal:** Foot at least 65% longer than shell, width approximately same as shell, semi-transparent, approximately eight irregular lateral marks, iridescent, pinkish-white, intermingled with occasional dull reddish-brown spots. Metapodium with smaller off-white marks, becoming progressively smaller and rounder distally. Marks more concentrated medially, giving impression of thin, medial line. Adjacent to medial line, concentrations of reddish-orange spots in two diffuse lines. Two or three reddish-orange spots close to edges, intermingling with whitish spots. Propodium translucent white distally, bearing small whitish marks. Tentacles semi-transparent, moderately long, thin, noticeably tapered, bearing two to four, irregularly spaced, small, bright, white marks. Black eyes with thin whitish, annular rings, located on swellings at base of tentacles. Siphon, semi-transparent, many small off-white spots, orange-red edges at base. Mantle with posterior cap-like area indicative of papillae. Chromatism comprising off-white background with large areas of yellowish-brown, variegated with many slightly different shades including brown, pink, dull red, white; approximately thirty irregularly shaped, slightly raised, light blue spots, being un-inflated pustules. Mantle roof off-white with grey areas.

**Distribution.** Only known from the type locality.

**Remarks.** *Granulina cartagenaensis* n. sp. is closest to *G. iridisa* n. sp. with which it is compared. These two species have much in common both in shell morphology and animal chromatism, and are probably closely related. The feature which clearly separates them is the almost globose shell with the W:L ratio of 74-76% which is significantly more inflated than *G. iridisa* with the W:L of 65-70%. Other differences are: in *G. iridisa* the metapodium lacks the diffuse orange-red lines and whitish medial line which is present in *G. cartagenaensis*.

**Figures 37-45**

**37-39.** *Granulina volcana* n. sp. Holotype. Off Islas Los Testigos, to north, Venezuela, 11°28'N, 63°06'W, 73 m. 2.67 x 1.87 mm, W:L 70%, MNHN 21985.

**40-42.** *Granulina calla* n. sp. Holotype. Isla Grande, Islas Los Testigos, Venezuela, 11°22.8'N, 63°08.1'W, 28 m. 2.57 x 1.75 mm, W:L 68%, MNHN 21954.

**43-45.** *Granulina Colonensis* n. sp. Holotype. Off Colon, to east, Panama, 9°31.5'N, 79°52.0'W, 57 m. 1.98 x 1.31 mm, W:L 66%, MNHN 21958.



It is believed that both *G. cartagenaensis* and *G. iridisa* have similar mantles - strongly pustulose and bearing five posterior papillae (Figs 16-17, and 20-23). Somewhat similar pale blue to turquoise spots are present on mantles of both species: in *G. iridisa* some of these spots can be seen inflated as small pustules while others are not inflated, indicating that their state of inflation is not coincident with the mantle state and may be deliberately controlled by the animal. The cap-like area is also similar in these two species, but in *G. cartagenaensis* it is more substantial. It is hypothesised that this is because the filling elements of un-inflated papillae are contained within, and the area would reduce in volume when papillae are inflated.

Inner whorls and plications can be seen through the semi-transparent dorsum (Fig. 55, 57). The type localities of these two species are approximately 600 miles apart.

**Etymology.** The name is taken from the type locality.

***Granulina waltergomezi* n. sp.**

Figs 18-19, 35-36, 52-54, 97, 113-116

**Type material.** Off Isla Chichime, San Blas Archipelago, Panama, 9°37.3'N, 78°53.2'W, 75-95 m. Holotype. 1.47 x 1.16 mm, W:L 79%, MNHN 21989; paratype 1. 1.50 x 1.13 mm, W:L 75%, MNHN 21990; paratype 2. 1.43 x 1.08 mm, W:L 75%, AWC; paratype 3. 1.62 x 1.20 mm, W:L 74%, AWC; paratype 4. 1.51 x 1.14 mm, W:L 75%, TMC; paratype 5. 1.53 x 1.14 mm, W:L 74%, TMC.

**Other material.** 19 ad. dd., off Isla Chichime, San Blas Archipelago, Panama, 9°37.3'N, 78°53.2'W, 75-95 m; Second colony located East Holandes Cays, San Blas, Panama, 9°35'N, 078°40'W, 15-20 m, sand, six specimens: 1.95 x 1.30 mm, W:L 72%, 1.44 x 1.09 mm, W:L 76%, 1.51 x 1.13 mm, W:L 75%, 1.54 x 1.17 mm, W:L 76%, 1.49 x 1.07 mm, W:L 72%, 1.48 x 1.11 mm, W:L 75%, and 3 ad. lv. TMC.

**Type locality.** Off Isla Chichime, San Blas Archipelago, Panama, 9°37.3'N, 78°53.2'W (Map ref. 2).

**Description.** Shell without colour, globose, slightly produced anteriorly. Size range 1.43 x 1.08 to 1.95 x 1.30 mm, W:L 72-79%. All external surfaces around aperture, including anterior and posterior canals, densely covered by minute, round, flat topped, lumpy deposits on scaly surface. Body whorl semi-transparent, moderately thick callus wash, lightly textured with minute lumps. Lip strongly curved, very strongly posteriorly, strongly curled inwards, moderately wide, widest medially; eighteen somewhat irregular denticles fill inner edge, widely spaced posterior medially, closely spaced anteriorly. Shoulder slightly raised above apex, gently rounded. In side

view, lip convex, more so anteriorly. External varix wide, strong, sinuous dorsal edge, widest and slightly raised on dorsum posterior medially, narrows posteriorly, sweeps around posterior canal weakly. Dorsal edge strong, continues around posterior canal widely as ridge below apex, develops into lumpy callus ridge ventrally, merges with parietal callus ridge. Varix narrows, sweeps around siphonal canal creating slightly produced base, blends into first, raised, columellar plication. Four plications fill approximately 43% of aperture. First evenly curved, moderately deep, narrow, raised. Second strong, strongly kinked on projected line of parietal callus ridge, tapering finger extends onto anterior callus and stops abruptly. Third and fourth weak, fourth weakest, both with small distal lump. Second, third and fourth plications weakly excavated. Parietal ridge weak, irregularly lumpy, extends from fourth plication, strengthens slightly posteriorly. Aperture moderately and evenly wide.

**Animal:** Length of foot at least twice length of shell, narrower, semi-transparent. Metapodium with random small off-white marks, intermingled with yellow and occasional rust spots, concentrated medially forming irregular, wide, distinct medial line on basal half, widening and becoming diffuse, fading distally. Close on each side of line, approximately twelve to fifteen additional yellow spots continue distally. Further off-white, more widely spaced marks extend to lateral edges. Propodium semi-transparent, largely covered by two or three diffuse, off-white marks. Tentacles semi-transparent, long, thin, five or six irregularly spaced marks, strongest distally. Eyes black, located on basal swellings, with diffuse, off-white, annular rings. Siphon short, thick, generally whitish, with many minute off-white, yellow and occasional black spots, whiter area basally. Mantle: Only observed in partially extended state. Small areas of off-white, yellowish-brown, reddish-brown and black colours can be detected. One axially located papilla projects posteriorly, with chromatism consisting of minute off-white spots arranged in spiral line wrapped around papilla in three turns, separated by narrow transparent line, rust spots clustered at base. Mantle roof greyish-white with numerous small, pale yellow spots, indistinct, transverse, pale off-white mark located posteriorly, slopes slightly downwards, to right at about 5° off horizontal.

**Distribution.** Known from the type locality and one other locality at 9°35'N, 078°40'W, 15-20 m, situated inside the islands of the San Blas archipelago, about eight miles to south east.

**Remarks.** *Granulina waltergomezi* n. sp. is the most inflated *Granulina* sp. to be described from the Caribbean and does not compare closely with any other described species. It is closest to *G. colonensis* n. sp., *G. darienensis* n. sp. and *G. nivalis* n. sp.



*Granulina colonensis* and *G. darienensis* are considerably larger, considerably less inflated and are colourful animals. *Granulina nivalis* shares somewhat similar shell morphology but is less inflated with W:L 61-71%, the surface texture is very much stronger and more evenly distributed over the entire shell surface (Figs 121-124), the chromatism is strikingly white, and it is a shallow water species.

**Etymology.** Walter Gomez crewed on the author's yacht during 2007 and 2008 on several expeditions. Many new species were collected and *Granulina waltergomezi* n. sp. is given his name in recognition of his valued help.

**Discussion.** During preparation of this article *Granulina waltergomezi* n. sp. was suspected of being one of two distinct new species due to differences in shell size, chromatism of the sole papilla and depth of the habitat between two closely related colonies. *Granulina waltergomezi* is a minute species and optical microscopy was unable to clearly show surface texture which was believed to be specific. When S.E.M images became available surface texture was studied closely and it was expected that this would show distinct differences between the two colonies. However, the S.E.M. images showed that the surface texture was somewhat variable but more significantly, these same variations were shared by both colonies. Therefore, the two colonies are now regarded as being the same species. It is probable that these two known colonies of *G. waltergomezi*, which do not interbreed, have not yet evolved to the point where they can be described as two distinct species.

***Granulina iridisa* n. sp.**

Figs 20-23, 58-60, 98

**Type material.** Cabo Codera, Venezuela, 10°35.2'N, 66°03.9'W, 18 m.

Holotype. 2.37 x 1.66 mm, W:L 70%, MNHN 21967; paratype 1. 2.90 x 1.89 mm, W:L 65%, MNHN 21968; paratype 2. 2.62 x 1.81 mm, W:L 69%, AWC; paratype 3. 2.75 x 1.88 mm, W:L 68%, TMC; paratype 4. 2.50 x 1.73 mm, W:L 69%, AWC; paratype 5. 2.43 x 1.67 mm, W:L 69%, TMC.

**Other material.** 5 ad. lv., 4 ad. dd., Cabo Codera, Venezuela, 10°35.2'N, 66°03.9'W, 18 m; 3 ad. dd., 1 juv. dd., off Cabo Codera, to west, 10°36.1'N, 66°06.0'W, 31 m, TMC.

**Type locality.** Cabo Codera, Venezuela, 10°35.2'N, 66°03.9'W, 18 m (Map ref. 13).

**Description.** Shell without colour, obovate. Size range 2.37 x 1.66 mm to 2.90 x 1.89 mm, W:L 65-70%. Body whorl semi-transparent, covered by very light callus wash, without apparent texture. Lip strongly curved, less so medially, curls inwards strongly, wide,

widest medially. Eighteen irregularly denticles almost fill inner edge, strongest in posterior half, very weak anteriorly. In side view, edge of lip slightly convex. External varix very strong, wide, wider medially, raised on dorsum, retains profile and sweeps around posterior canal, develops into strong lumpy callus ridge ventrally, merges with parietal callus ridge. Strong callus deposits close to dorsal edge of varix form secondary ridge which sweeps around both posterior and anterior canals, ending at parietal ridge and third columellar plication respectively. Both posterior and anterior ventral callus deposits are strikingly opaque white with clearly defined edges. Labial edge of varix, remaining strong, sweeps around siphonal canal, merges with slightly raised first plication. Four plications fill approximately 40% of aperture, first weak, thin, evenly wide. Second strongest, strongly kinked, strong pointed finger projects from bottom of lump, blends into anterior callus distally. Third strong, short, with distal lump. Fourth weakest with small, rounded, distal lump. Second, third and fourth plication excavated, second weakly. Moderately strong parietal ridge extends posteriorly from plications. Aperture moderately wide, slightly more so anteriorly. Surfaces of all callus deposits textured with minute pustules.

**Animal:** Length of fully extended foot unknown, width approximately same as shell, semi-transparent with about five irregular shaped marks laterally, anterior marks pinkish, strikingly iridescent. Off-white marks with yellowish hue extend over metapodium; two diffuse red lines extend distally. Propodium substantially off-white with some minute indistinct pinkish spots. Tentacles translucent white, long, thin, with moderately heavy off-white marks, particularly distally. Black eyes located on slight swellings at base of tentacles. Siphon moderately long, semi-transparent with many small off-white spots, intermingled with minute brown spots distally. Mantle with five simple papillae grouped posteriorly on pale cap-like area. The three medial papillae each bear approximately ten yellowish spots, laterals without spots. Mantle chromatism with irregularly shaped pale or dark areas. Pale areas laterally and on closing edges, yellowish with many small brown spots. Dark areas anterior laterally and posteriorly comprised of minute black, dull yellow, orange, dull green spots, and larger, bright turquoise spots which appear to be un-inflated pustules. Inflated pustules pale blue, bright turquoise when not inflated. Mantle roof substantially yellowish-white with pale orange spots. Approximately eleven short, yellow, elongate marks on darker patch emerge from under anterior dorsal callus and fan out posteriorly. Pale, yellowish-white, transverse band located posteriorly, sloping slightly downwards to right.

**Distribution.** Only known from the type locality and adjoining areas within three mile range to north west.

**Remarks.** *Granulina iridisa* n. sp. is closest to *G. cartagenaensis* n. sp. (Figs 16-17, 55-57, 96) with which it is compared, and with which it has much in common both in shell morphology and animal chromatism, suggesting that they are closely related. *Granulina cartagenaensis* is slightly smaller, but very significantly more inflated at W:L 74-76%, compared with W:L 65-70% of *G. iridisa*, which alone, separates these two species. Other differences are: the first plication in *G. iridisa* is not excavated; the second is stronger, strongly kinked downwards and points less obliquely downwards (Fig. 98) than *G. cartagenaensis* (Fig. 96); the dorsal callus is considerably heavier, has strikingly opaque white margins which are more clearly defined; lacks the diffuse orange-red lines and whitish medial line present on the metapodium of *G. cartagenaensis*. The type localities of these two species are approximately 600 miles apart.

**Etymology.** The name refers to the iridescent lateral marks on the foot, *iridis* being the Latin for iridescent.

***Granulina monjesensis* n. sp.**

Figs 24-26, 61-63, 99

**Type material.** Harbour, Monjes del Sur, Venezuela, 12°21.5'N, 70°54.1'W, 3-10 m.

Holotype. 1.74 x 1.27 mm, W:L 73%, MNHN 21969; paratype 1. 1.68 x 1.20 mm, W:L 71%, MNHN 21970; paratype 2. 1.73 x 1.23 mm, W:L 71%, AWC; paratype 3. 1.75 x 1.24 mm, W:L 71%, AWC; paratype 4. 1.83 x 1.40 mm, W:L 76%, TMC; paratype 5. 1.67 x 1.20 mm, W:L 72%, TMC.

**Other material.** 6 ad. lv., Harbour, Monjes del Sur, Venezuela, 12°21.5'N, 70°54.1'W, 3-10 m, TMC.

**Type locality.** Harbour, Monjes del Sur, Venezuela, 12°21.5'N, 70°54.1'W (Map ref. 9).

**Description.** Shell without colour, pyriform. Size range 1.67 x 1.20 mm to 1.83 x 1.40 mm, W:L 71-76%. Dorsum semi-transparent, finely striate, lightly textured. Lip slightly curved anteriorly, very strongly posteriorly, curled inwards, moderately wide, widest posterior medially, twelve weak, irregular denticles on inner edge fade out below labial insertion, very weak

anteriorly. In side view, lip convex, more so posteriorly. External varix strong, moderately wide, widest posteriorly, narrow anteriorly. Dorsal edge slightly concave with strong groove, gently rounded shoulder, sweeps around posterior canal, spreads over dorsum as heavy callus, fades ventrally. Weak, uneven, posterior ridge merges with parietal callus ridge. Weakening varix sweeps around wide siphonal canal, merges with anterior callus, labial edge merges into slightly raised first columellar plication. Anterior callus triangular in shape, uneven, heavy, defined by two external edges, one short and strong at first columellar plication, weakening, slopes upwards onto dorsum at approximately 30° to shell axis, second weaker, slopes upwards towards aperture at right-angles to first, merges with parietal ridge (Fig. 61). Four plications fill approximately 36% of aperture; first moderately deep, widening as it emerges, raised. Second strong, strongly kinked, slightly raised as it emerges, wide finger broadly rounded with flat lump distally, extends onto callus. Third weak, emerges as wide, flat lump, tapers finely and fades on anterior callus. Fourth plication can be detected deep within aperture, does not emerge. Parietal ridge irregularly strong, not clearly defined basally, weak medially. All plications excavated, first very weakly. Aperture moderately wide, more so anteriorly. Surface of all callus deposits, including lip, textured.

**Animal:** Foot more than twice shell length, width narrower than shell, semi-transparent. Metapodium with random small yellow-white marks, concentrated medially, forming irregular, strong, distinct, white medial line, extends distally, becoming diffuse and yellowish. Adjacent to medial line, on each side, approximately six dull dark reddish-brown spots intermingled with small yellow-white marks which extend to edges. Edges highlighted by line of small elongated, yellow-white marks. Propodium semi-transparent, covered by fine yellow-white spots. Tentacles semi-transparent, long, thin, five or six irregularly spaced marks distally, diffuse rust marks evident basally. Black eyes with off-white annular rings located on basal swellings. Siphon medium length, thick, semi-transparent, largely covered with fine spots, off-white at base, yellowish distally.

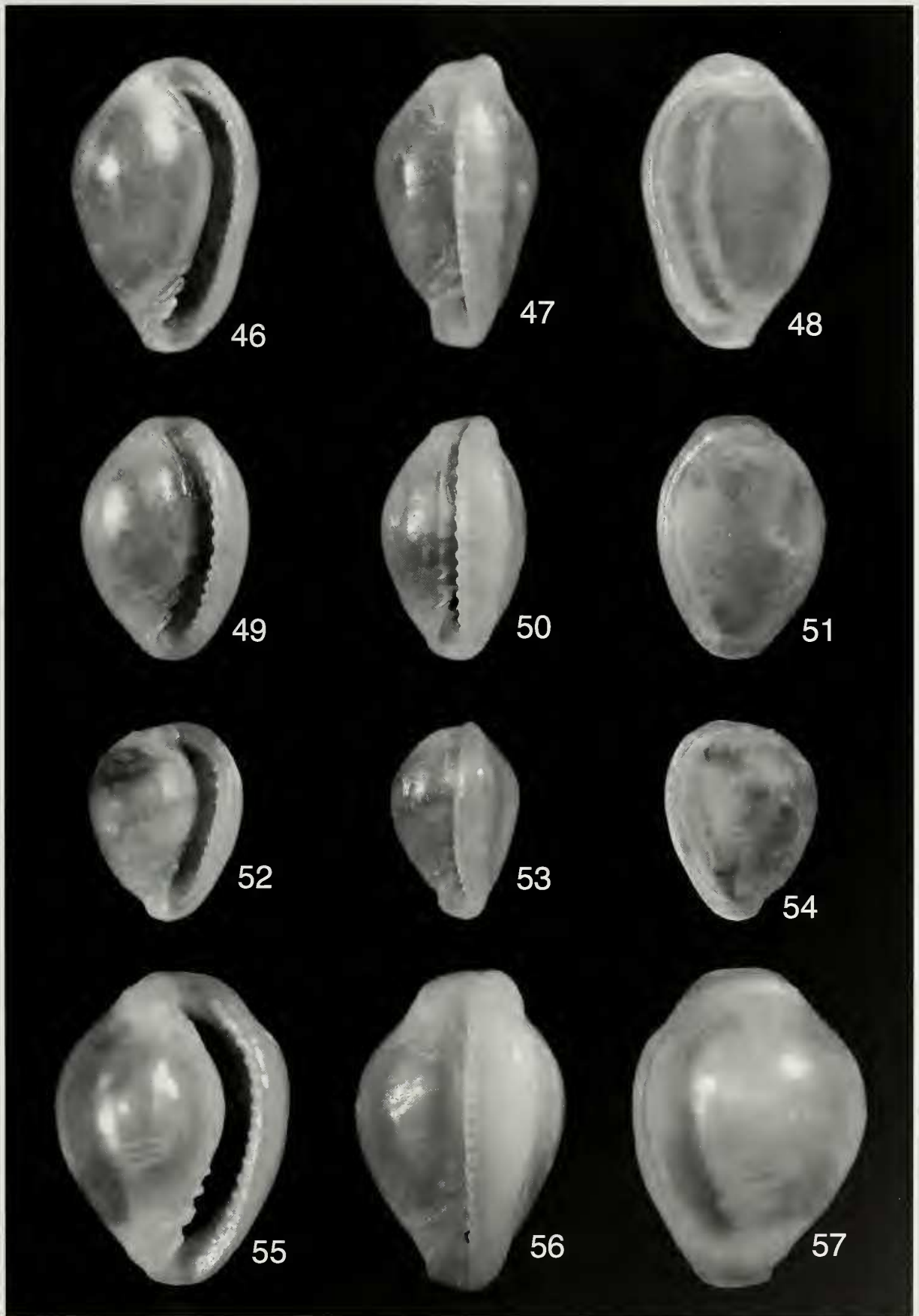
**Figures 46-57**

**46-48.** *Granulina darienensis* n. sp. Holotype. Off Isla Chichime, San Blas, Panama, 9°37.3'N, 78°53.2'W, 75 m. 2.14 x 1.39 mm, W:L 65%, MNHN 21960.

**49-51.** *Granulina gayracaensis* n. sp. Gayraca Bay, Santa Martha, Colombia, 11°19.5'N, 74°06.3'W, 7 m. Holotype. 1.75 x 1.22 mm, W:L 69%, MNHN 21962.

**52-54.** *Granulina waltergoinezi* n. sp. Off Chichime, San Blas Archipelago, Panama, 9°37.3'N, 78°53.2'W, 75-95 m. Holotype. 1.47 x 1.16 mm, W:L 79%, MNHN 21989.

**55-57.** *Granulina cartagenaensis* n. sp. Off Cartagena, Colombia, 10°22.4'N, 75°35.8'W, 25-41 m. Holotype. 2.33 x 1.77 mm, W:L 76%, MNHN 21956.



Mantle: Only partially observed, weakly pustulose, chromatism combining many bright colours including turquoise, red, orange yellow, black and white. Melanism is common in this species (Fig. 25). Mantle roof greyish white with numerous small, pale yellow-white and pale orange spots. Indistinct, posterior, transverse, pale, off-white mark, slopes slightly downwards to left at about 5° off horizontal.

**Remarks.** *Granulina monjesensis* n. sp. is closest to *G. plagula* n. sp. with which it is compared. The shell morphology is somewhat similar, but *G. plagula* has a higher shoulder, aperture widens strongly anteriorly, and the ridge defining the anterior callus is very weak. Other significant differences are present in animals: In *Granulina plagula*, the metapodium is sparsely covered with yellow-white and reddish-brown spots, the mantle is translucent grey-white with occasional dark brown marks and smaller greyish white spots. Some small pale dull orange spots are associated with the dark brown marks. The chromatism of *G. monjesensis* is comprised of considerably smaller spots in bright colours with significant absence of brown.

**Distribution.** Only known from the type locality.

**Etymology.** The name is taken from the type locality.

***Granulina plagula* n. sp.**

Figs 27, 64-66, 100

**Type material.** Boca Grandi, Aruba, 12°27.3'N, 59°52.6'W, 1-2 m.

Holotype. 1.63 x 1.14 mm, W:L 70%, MNHN 21979; paratype 1. 1.80 x 1.20 mm, W:L 67%, MNHN 21980; paratype 2. 1.60 x 1.08 mm, W:L 67%, AWC; paratype 3. 1.68 x 1.13 mm, W:L 67%, AWC; paratype 4. 1.71 x 1.12 mm, W:L 66%, TMC; paratype 5. 1.72 x 1.11 mm, W:L 65%, TMC.

**Other material.** 95 ad. lv., 10 juv. lv., Boca Grandi, Aruba, 12°27.3'N, 59°52.6'W, TMC.

**Type locality.** Boca Grandi, Aruba, 12°27.3'N, 59°52.6'W (Map ref. 10).

**Description.** Shell without colour, obovate. Size range 1.60 x 1.08 mm to 1.80 x 1.20 mm, W:L 65-70%. Dorsum semi-transparent, finely striate, light callus wash, textured. Lip curved, very strongly posteriorly,

curled inwards medially, slightly flared anteriorly. Eight weak denticles on inner edge anterior medially, very weak anteriorly, absent posteriorly. In side view, lip evenly convex. External varix wide, widest posteriorly, narrowest anteriorly, dorsal edge almost straight with strong dorsal groove, gently rounded shoulder, weakens, sweeps around posterior canal, widening over dorsum as moderately heavy callus, forms short lumpy ridge ventrally, merges with parietal callus ridge. Weakening varix sweeps around wide, somewhat pointed siphonal canal, merges with anterior callus, labial edge merges with first columellar plication. Four plications fill approximately 39% of aperture; first somewhat uneven in width medially, moderately deep; second stronger, curves anteriorly, extends unusually far onto anterior callus; third narrow, weak, elongate lump distally, curving anteriorly; fourth very weak, distal lump extends anteriorly to join distal lump on third. Parietal ridge extends posteriorly and weakens. Emergent body whorl with very wide callus extending from plications to join posterior callus, margin defined by translucent white line. All plications excavated, first very weakly. Surface of all callus deposits, including lip, textured. Aperture wide posteriorly, less wide medially, widening evenly anteriorly, becoming very wide basally.

Animal: Length of fully extended foot approximately twice length of shell, width narrower. Metapodium elongated distally, irregular yellow-white marks medially forming diffuse medial line, whiter basally, fading distally, otherwise lightly covered with small yellow-white spots intermingled with fewer small reddish-brown spots. Tentacles semi-transparent, long, thin (when fully extended), five off-white marks on distal half, some diffuse rust marks evident basally. Eyes black, on slight basal swellings. Siphon long, moderately thick, semi-transparent, many small off-white and rust spots, whiter posteriorly. Mantle weakly pustulose, translucent pale grey-white, pustules off-white, occasional small off-white marks of various sizes, six or seven large irregular dark brown marks bearing occasional minute, orange-red and off-white spots. Mantle roof only partially observed: background brownish-white with moderately large off-white spots and occasional pale dull orange spots.

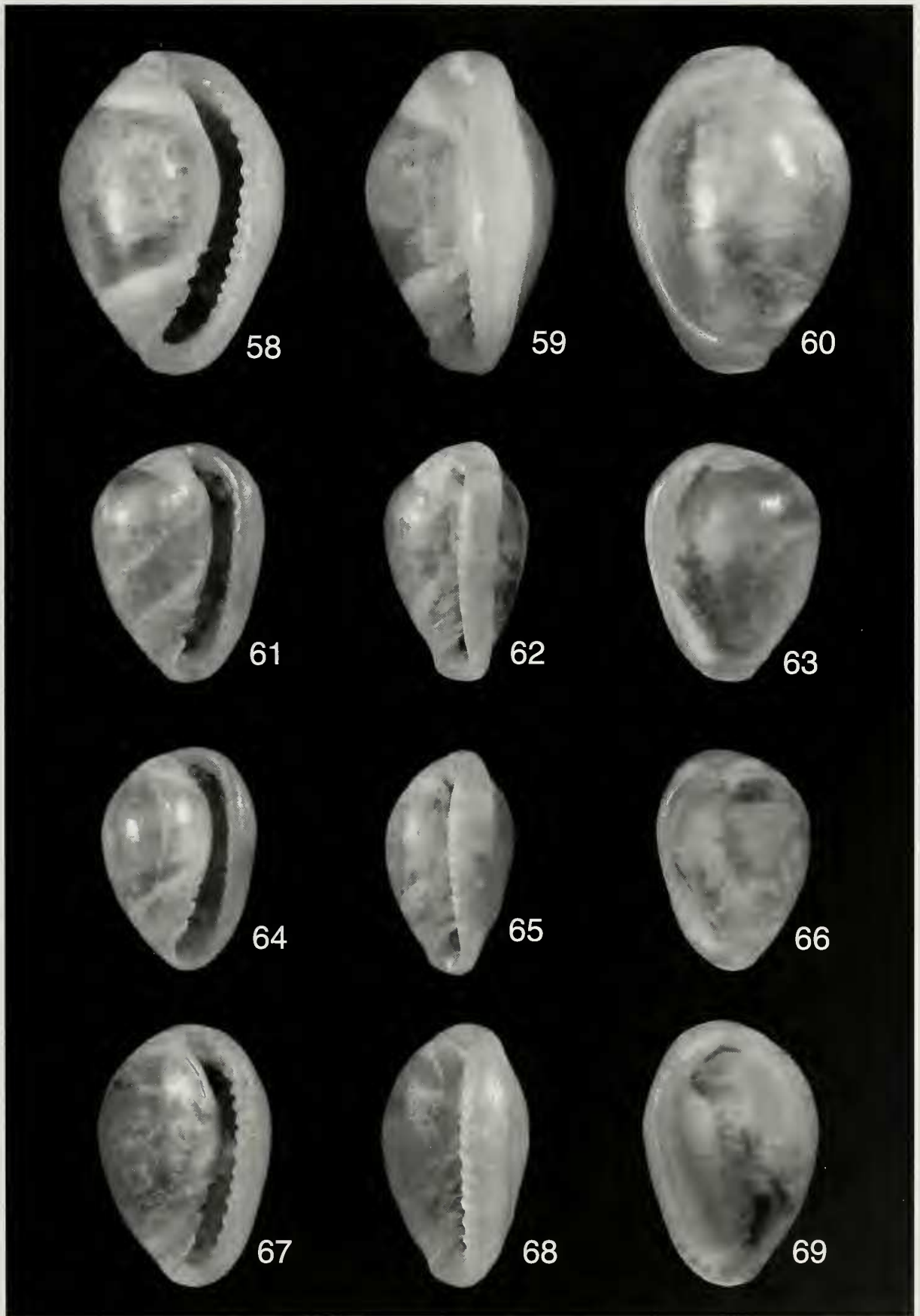
**Figures 58-69**

**58-60.** *Granulina iridisa* n. sp. Cabo Codera, Venezuela, 10°35.2'N, 66°03.9'W, 18 m. Holotype. 2.37 x 1.66 mm, W:L 70%, MNHN 21967.

**61-63.** *Granulina monjesensis* n. sp. Holotype. Harbour, Monjes del Sur, Venezuela, 12°21.5'N, 70°54.1'W, 3-10 m. 1.74 x 1.27 mm, W:L 73%, MNHN 21969.

**64-66.** *Granulina plagula* n. sp. Holotype. Boca Grandi, Aruba, 12°27.3'N, 59°52.6'W, 1-2 m. 1.63 x 1.14 mm, W:L 70%, MNHN 21979.

**67-69.** *Granulina ovata* n. sp. Holotype. Off Isla Cubagua, to north, Venezuela, 10°52.4'N, 64°12.4'W, 22 m. 1.95 x 1.30 mm, W:L 67%, MNHN 21977.



**Distribution.** Only known from the type locality.

**Remarks.** *Granulina plagula* n. sp. is close to *G. minae* Espinosa & Ortea, 2000, from Costa Rica but is closer to *G. ocella* n. sp. with which it is here compared. The shell shape of *G. ocella* is somewhat similar, but *G. plagula* is bigger, without any overlap in shell size, and less inflated at W:L 65-70% compared with *G. ocella* at W:L 70-73% - only a slight overlap. Significant differences are: the distal end of second plication in *G. plagula* extends further onto the anterior callus and fades out, callus wash extends clearly onto the dorsum ventrally, the parietal callus ridge is not clearly defined, whereas, in *G. ocella* the second plication is shorter and ends abruptly, the parietal ridge is very straight and clearly defined. Most significantly, the mantle chromatism of *G. plagula* has three large dark brown spots on a translucent grey-white background with some off-white spots, whereas, *G. ocella* has three large, bright ocellated marks with turquoise and orange predominating, on a background of fine, yellowish-white spots intermingled with fine, black spots.

*Granulina minae* Espinosa & Ortea, 2000, from Costa and *G. gnanajatabey* Espinosa & Ortea, 2003, from Cuba, were both compared to *G. antillensis* (De Jong and Coomans, 1988). However, as more Caribbean *Granulina* species are discovered it becomes clear that *G. antillensis* belongs to a different group of *Granulina* species found in deeper water and having shell morphology with slightly produced ends amongst other features. Typical of this group is *G. colonensis* n. sp. (Figs 43-45). Like *Granulina plagula* and *G. ocella*, *G. minae* and *G. gnanajatabey* are both found in relatively shallow water, down to 15 m. *G. minae* is eliminated from comparison with *G. plagula* by its chromatism which is yellow and orange, and *G. gnanajatabey* by its shell shape.

**Etymology.** The name is taken from the chromatism of the mantle which can be likened to a curtain. The Latin word *plagula* translates as curtain.

***Granulina ovata* n. sp.**

Figs 28-29, 67-69, 101, 129-132

**Type material.** Off Isla Cubagua, to north, Venezuela, 10°52.4'N, 64°12.4'W, 22 m.

Holotype. 1.95 x 1.30 mm, W:L 67%, MNHN 21977; paratype 1. 2.16 x 1.41 mm, W:L 65%, MNHN 21978; paratype 2. 1.95 x 1.31 mm, W:L 67%, AWC; paratype 3. 2.04 x 1.30 mm, W:L 64%, AWC; paratype 4. 2.08 x 1.35 mm, W:L 65%, TMC; paratype 5. 1.93 x 1.26 mm, W:L 65%, TMC.

**Other material.** 10 ad. lv., 1 juv. ad., 2 ad. dd., off Isla Cubagua, to north, Venezuela, 10°52.4'N, 64°12.4'W, 22 m; 19 ad. lv. 5 juv. lv., 27 ad. dd., Margarita Channel, off Isla Coche, to north, Venezuela, 11-50 m. mud, TMC (Map ref. 14).

**Type locality.** Off Isla Cubagua, to north, Venezuela, 10°52.4'N, 64°12.4'W (Map ref. 14).

**Description.** Shell without colour, ovate, somewhat pointed anteriorly. Size range 1.93 x 1.26 mm to 2.16 x 1.41 mm, W:L 64-67%. Body whorl semi-transparent, slightly striate; moderate callus wash, moderately textured. Lip gently curved, more so posteriorly, curls inwards strongly, wide, slightly wider medially. Fourteen strong, even denticles fill inner edge. In side view, lip, mainly straight, turns sharply to right posteriorly. External varix strong, very wide, widest anterior medially, dorsal edge straight, sweeps to right posteriorly then smoothly around posterior canal without creating shoulder, weakens and forms moderately strong ridge ventrally, merges with parietal callus ridge. Some posterior callus extends from weakening varix over dorsum. Weakening varix sweeps around siphonal canal, merges with weak anterior callus, labial edge merges with weak, very slightly raised first columellar plication. Four plications fill approximately 43% of aperture, all excavated. First moderately strong, thickened medially. Second, wide, flat, short, pointed finger extends from bottom onto anterior callus distally. Third weak, distal lump terminates in short, convex, axial lump forming small curved ridge. Fourth ends abruptly, internally on parietal wall. Posterior edge of anterior callus slightly thickened, sweeps upwards, merges with weak broken, irregularly thick, parietal ridge. Aperture, evenly wide over complete length, curved more strongly posteriorly. Surfaces of all callus deposits textured with minute pustules.

**Animal:** Foot more than twice shell length, width narrower than shell, semi-transparent. Approximately six pinkish, lateral marks increase in size posteriorly, comprised of diffuse concentrations of minute spots of various colours – off-white, brown, rust, occasional black. Metapodium only observed in rounded state distally. Minute white spots concentrated medially form very strong wide line, widening posteriorly, does not reach to distal end. Area around white medial line lightly marked with minute off-white marks. Propodium semi-transparent, some diffuse off-white marks medially. Tentacles very long, thin, small off-white marks, slightly stronger distally, traces of rust evident at base. Black eyes located on small swellings at base of tentacles. Siphon semi-transparent, almost totally covered by minute off-white marks, whiter at base, strongest laterally. Mantle not observed fully extended, weakly pustulose, one single, translucent, off-white papilla observed (Not figured). Three large, irregularly ocellated marks, grey centres with four rings of dull brownish colours, one located posteriorly, one each side anteriorly, separated by pale areas. Mantle roof substantially yellowish-white or pale grey, many dull orange spots. Pale transverse band located towards posterior, sloping strongly,

downwards to right, edged with orange-brown posteriorly.

**Distribution.** Only known from the type locality.

**Remarks.** *Granulina ovata* n. sp. is closest to *G. gayracaensis* n. sp. with which it is compared. *Granulina gayracaensis* has perfectly oval shell with a medial widest point, is smaller at 1.61 - 1.92 mm and more inflated at W:L 67-71% than *G. ovata* at 1.93 - 2.16 mm and W:L 64-67%. The plications show small, but significant differences (as described above). The most significant feature separating these two species is the very distinct white, medial line on the metapodium of *G. ovata*, which is absent in *G. gayracaensis*. Presence of papillae on the mantle is omitted from this comparison due to insufficient data being available. Type localities are approximately 750 miles apart.

**Etymology.** The name refers to the oval shape of the shell, the Latin for oval being *ovatus*.

***Granulina ocella* n. sp.**

Figs 30-32, 73-75, 102

**Type material.** East Holandes Cays, San Blas, Panama, 9°35'N, 078°40'W, 3 m.

Holotype. 1.52 x 1.12 mm, W:L 74%, MNHN 21973; paratype 1. 1.56 x 1.14 mm, W:L 73%, MNHN 21974; paratype 2. 1.53 x 1.10 mm, W:L 72%, AWC; paratype 3. 1.54 x 1.09 mm, W:L 71%, AWC; paratype 4. 1.44 x 1.05 mm, W:L 73%, TMC; paratype 5. 1.53 x 1.07 mm, W:L 70%, TMC.

**Other material.** Lot of approximately 200 ad. lv., east Holandes Cays, San Blas, Panama, 9°35'N, 078°40'W, 3 m, TMC.

**Type locality.** East Holandes Cays, San Blas, Panama, 9°35'N, 078°40'W (Map ref. 3).

**Description.** Shell minute, without colour, pyriform. Size range 1.44 x 1.05 mm to 1.56 x 1.14 mm, W:L 70-74%. Dorsum semi-transparent, occasional striations, light callus wash, lightly textured. Lip gently curved anteriorly and medially, very strongly posteriorly. Curled inwards, moderately wide, less wide posteriorly. Eight weak denticles on anterior half, extremely weak in posterior half. In side view, lip convex, more so posteriorly. External varix wide, widest posteriorly medially, narrowest anteriorly, dorsal edge straight with strong groove, rounded at shoulder, highest above insertion point where it fades out. Callus line present on dorsum close to varix, forms circular deposit around immersed spire. Further light callus spreads around posterior canal and forms ridge ventrally to merge with parietal callus ridge. Weakening varix sweeps around wide siphonal canal, merges with weak anterior callus, labial edge merges

with raised first columellar plication. Four plications fill approximately 33% of aperture. First wide, deep. Second wide, close to first with deep, clearly defined groove between, widened at distal lump causing bifurcation, stops abruptly on anterior callus. Third deeply excavated, small distal lump angled downwards, almost touches second. Fourth discontinuous due to very deep excavation, small distal lump merges with very straight, clearly defined but lumpy, parietal ridge. Surface of all callus deposits textured. Aperture moderately wide, slightly wider anteriorly.

**Animal:** Foot more than twice shell length, width narrower, semi-transparent. Metapodium with small, yellow-white marks, concentrated to form irregular, diffuse medial line extending distally. Adjacent to centre line, six dark reddish-brown spots, intermingled with small yellow-white marks extending to edges. Propodium semi-transparent, covered by five or six yellow-white spots. Tentacles semi-transparent, long, thin, five or six irregularly spaced marks strongest distally, diffuse rust marks evident basally. Eyes black, located on basal swellings, off-white annular rings. Siphon medium length, thick, semi-transparent, largely covered with off-white spots, yellowish-white distally, intermingled with occasional minute, dull reddish-brown spots, less so at base. Mantle: Sparsely pustulose, two larger pustules located posteriorly on closing edge of mantle, background yellow-white. Main feature of chromatism: three broadly round, large, ocellated spots, turquoise centre encircled by thin black ring, wider orange ring and further thin black ring. Three or four less distinct marks located randomly, all separated by minute yellow-white and black spots. Melanism is common in this species (Fig. 32). Mantle roof greyish white with numerous small, pale yellow-white and pale orange spots. Indistinct, posterior, transverse, pale off-white mark slopes slightly downwards to right at about 5° off horizontal.

**Remarks.** *Granulina ocella* n. sp. is compared with *G. minae* Espinosa & Ortea, 2000, from Costa Rica to which it appears to be closely related. The shells of both species are pyriform, but *G. minae* is somewhat more pointed. The main differences are in the animal chromatism: *G. ocella* exhibits three striking turquoise ocellated spots which are absent in *G. minae*, and *G. minae* exhibits a number of yellow longitudinal grooves on the anterior part of the mantle roof; a posterior snow white pustule on the mantle amongst others which are yellow; the overall colour is mainly yellow. All these features differ from *G. ocella*.

**Distribution.** Only known from the type locality.

**Etymology.** The name refers to the brightly coloured spots on the mantle which are likened to an eye or gem, for which the Latin is *ocellus*.

***Granulina nivalis* n. sp.**

Figs 33-34, 76-78, 103, 121-124, 136-141

**Type material.** Las Aves de Sotavento, Venezuela, 12°01.66'N, 067°38.05'W, 1 m.

Holotype. 1.62 x 1.15 mm, W:L 71%, MNHN 21971; paratype 1. 1.72 x 1.17 mm, W:L 68%, MNHN 21972; paratype 2. 1.69 x 1.21 mm, W:L 71%, AWC; paratype 3. 1.39 x 0.98 mm, W:L 71%, AWC; paratype 4. 1.41 x 0.96 mm, W:L 68%, TMC; paratype 5. 1.70 x 1.17 mm, W:L 69%, TMC.

**Other material.** 4 spms: 1.72 x 1.18, W:L 69%, 1.74 x 1.16, W:L 67%, 1.75 x 1.19, W:L 68%, 1.78 x 1.22 mm W:L 68%, and approximately 40 additional spms. from numerous stations within type locality, TMC.

**Type locality.** Las Aves de Sotavento, Venezuela, 12°01.66'N, 067°38.05'W (Map ref. 12).

**Description.** Shell without colour, ovate, surface dull. Size range 1.39 x 0.98 mm to 1.78 x 1.22 mm, W:L 67-71%. Body whorl translucent white. All external surfaces densely textured. Lip evenly curved, strongly curled inwards, wide, fifteen strong, denticles, slightly more widely spaced medially, fill inner edge. In side view, lip convex, more so posteriorly. External varix wide, moderately strong, widest medially, dorsal edge straight, gradually narrows and sweeps around posterior canal, fades out ventrally as weak lumpy ridge, merges with parietal callus ridge. Weakening varix sweeps around evenly curved siphonal canal, blends into anterior callus; labial edge merges with first columellar plication. Four plications fill approximately 42% of aperture, all moderately excavated. First plication narrow with small raised lump. Second strong, strongly kinked at lump on emergent end, short, weak finger blends distally into anterior callus. Third strong, short, with distal lump. Fourth does not emerge, almost imperceptible lump externally. All lumps on plications aligned with smooth, parietal ridge extending posteriorly from plications. Surface of shell covered with deposit of minute roundish lumps (Figs 121-124), some axial alignment apparent. Aperture moderately wide, slightly wider anteriorly.

Animal: Length of foot more than twice shell length, width narrower, metapodium widening before narrowing and tapering to very narrow, elongate point

distally. Chromatism of external parts: almost totally white, white marks on translucent foot, marks being largest laterally and medially on emergent metapodium, smaller and diffuse on remainder. Propodium with white diffuse marks. Tentacles semi-transparent, long, thin, four to six white marks spaced along length, small brown marks basally. Eyes located on slight basal swellings, black with weak, white annular rings. Siphon short, white, thick (possibly not observed fully extended). Mantle: not observed extended, several un-inflated lateral, white swellings evident, indicating that mantle is pustulose. One moderately long, posterior pustule evident (it is not known if this can extend to become a long papilla). One small distinct brownish mark on posterior edge. Mantle roof white with numerous very pale brownish orange spots.

**Distribution.** Only known from the type locality.

**Habitat.** Sand on and close to dead coral rocks and rubble in shallow water to 3 m.

**Remarks.** *Granulina nivalis* n. sp. appears to be most closely related to *G. ovata* n. sp. with which it is compared. Shell morphology is similar, but the shell surface of *G. ovata* is significantly less textured and the shell is significantly bigger: size range 1.93 x 1.26 mm to 2.16 x 1.41 mm, W:L 64-67%, compared to *G. nivalis* with size range 1.39 x 0.98 mm to 1.78 x 1.22 mm, W:L 67-71%. Animal chromatism is significantly different: *G. ovata* is strongly coloured compared to the unusually white chromatism of *G. nivalis*.

**Etymology.** The name refers to the snow white chromatism and snow-like pattern on the metapodium, and is taken from the Latin word *nivalis* meaning snowy.

***Granulina velaensis* n. sp.**

Figs 70-72, 104

**Type material.** Off Cabo de Vela, Colombia, 11°57'N, 72°36'W, 58 m.

Holotype. 2.80 x 1.94 mm, W:L 69%, MNHN 21987; paratype 1. 2.82 x 1.94 mm, W:L 69%, MNHN 21988; paratype 2. 2.77 x 1.84 mm, W:L 66%, AWC; paratype 3. 2.83 x 2.00 mm, W:L 71%, AWC; paratype 4. 3.24 x 2.12 mm, W:L 66%, TMC; paratype 5. 2.46 x 1.63 mm, W:L 66%, TMC.

**Figures 70-81**

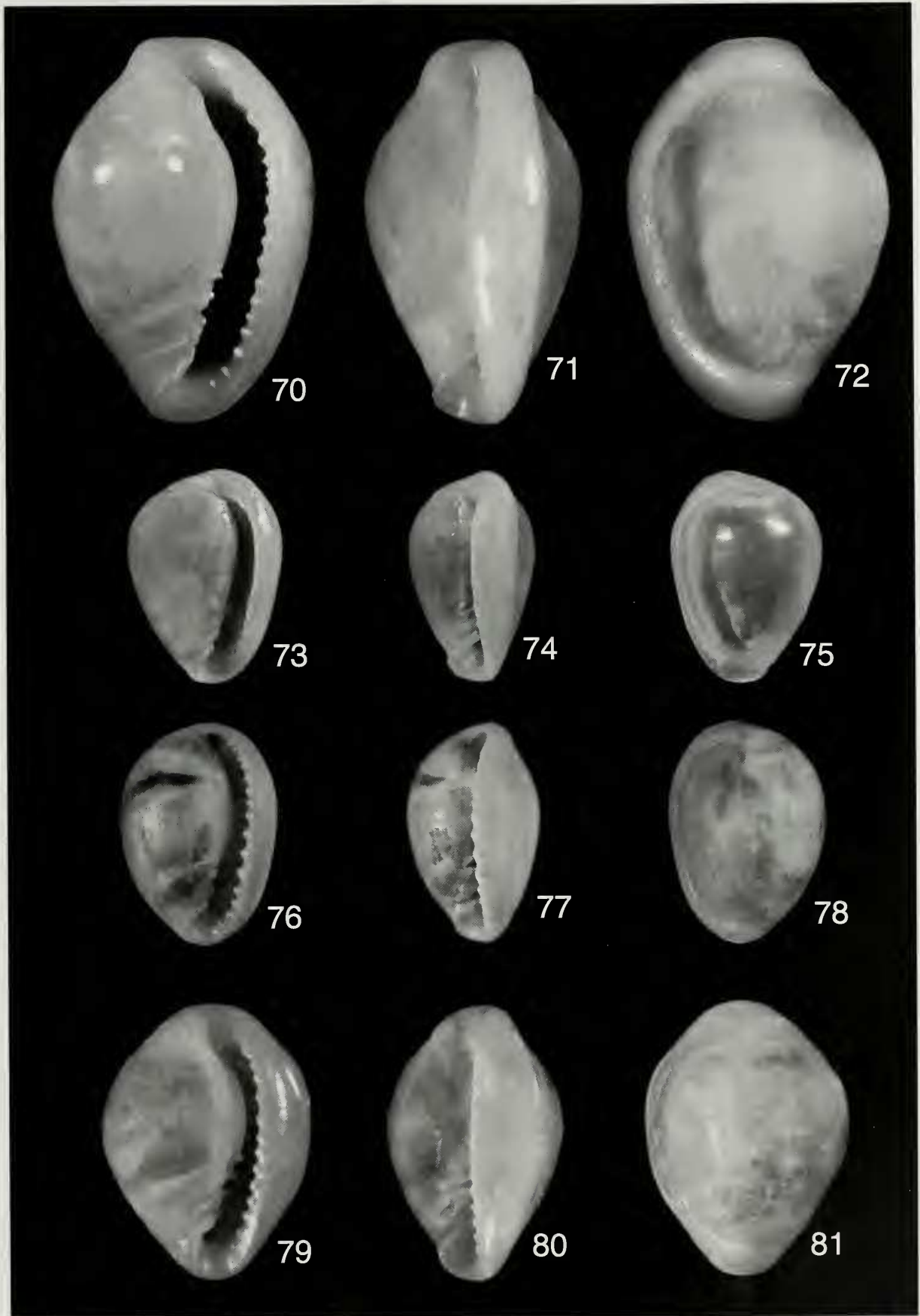
**70-72.** *Granulina velaensis* n. sp. Holotype. Off Cabo de Vela, Colombia, 11°57'N, 72°36'W, 58 m. 2.80 x 1.94 mm, W:L 69%, MNHN 21987.

**73-75.** *Granulina ocella* n. sp. Holotype. East Holandes Cays, San Blas, Panama, 9°35'N, 078°40'W, 3 m. 1.52 x 1.12 mm, W:L 74%, MNHN 21973.

**76-78.** *Granulina nivalis* n. sp. Holotype. Las Aves de Sotavento, Venezuela, 12°01.66'N, 067°38.05'W, 1 m, 1.62 x 1.15 mm, W:L 71%, MNHN 21971.

**79-81.** *Granulina pinguisa* n. sp. Holotype. Off Cabo de Vela, Colombia, 12°06.7'N 72°19.3'W, 50-59 m. 2.02 x 1.53 mm, W:L 76%, MNHN 21975.





**Other material.** Lot of 100 plus ad. dd., off Cabo de Vela, Colombia, 11°57'N, 72°36'W, 58 m, TMC.

**Type locality.** Off Cabo de Vela, Colombia, 11°57'N, 72°36'W (Map ref. 7).

**Description.** Shell without colour, obovate, slightly produced at both ends. Size range 2.46 x 1.63 mm to 3.24 x 2.12 mm, W:L 66-71%. Body whorl semi-transparent, dorsum unusually striate posteriorly, covered by light callus wash with light texture. Lip gently curved, slightly more so posterior medially, curls inwards strongly, wide, more so medially, eighteen irregular denticles completely fill inner edge, more widely spaced posteriorly. In side view, lip slightly sinuous. External varix wide, extremely strong, only slightly raised on dorsum, sweeps around wide, posterior canal, forms lumpy posterior callus ridge, merges with moderately strong parietal callus ridge. Varix remains strong, sweeps around weak siphonal canal, merges into strong, wide anterior callus, labial edge weakens, merges with slightly raised, first columellar plication. Four plications fill approximately 38% of aperture. All plications slightly excavated. First moderately deep and narrow, slightly kinked medially. Second strongest, slightly kinked at wide, elongated lump, long tapering finger distally fades out on strong anterior callus. Third weaker, short with pointed distal lump. Fourth weakest, short with pointed distal lump. Moderately strong, wide parietal ridge commences at third plication. Aperture wide, slightly more so anteriorly. Surfaces of all callus deposits, and lip, textured with minute pustules.

**Distribution.** Only known from the type locality.

**Remarks.** No live animals were collected. Shell morphology indicates that *Granulina velaensis* n. sp. is closest to *G. iridisa* with which it is compared. *Granulina velaensis* is approximately 10 % larger and similarly inflated, unusually striate, particularly posteriorly, and more heavily textured. The most significant differences are the unusually strong external varix, slightly produced and wider posterior, and more flared siphonal canal compared to the

medially widened varix which is more extensively raised on the dorsum, and the distinctive form of callus deposits on the emergent body whorl of *G. iridisa*. (Figs 58-60). Type localities are approximately 380 miles apart.

**Etymology.** The name is taken from the type locality.

***Granulina piuguisa* n. sp.**

Figs 79-81, 105

**Type material.** Off Cabo de Vela, Colombia, 12°06.7'N 72°19.3'W, 50-59 m.

Holotype. 2.02 x 1.53 mm, W:L 76%, MNHN 21975; paratype 1. 1.77 x 1.30 mm, W:L 74%, MNHN 21976; paratype 2. 1.75 x 1.24 mm, W:L 71%, AWC; paratype 3. 1.86 x 1.40 mm, W:L 75%, AWC; paratype 4. 1.74 x 1.23 mm, W:L 71%, TMC; paratype 5. 1.83 x 1.31 mm, W:L 72%, TMC.

**Other material.** 4 ad. dd., off Cabo de Vela, Colombia, 12°06.7'N, 72°19.3'W, 50-59 m; 3 ad. dd., 1 juv., dd., off Cabo de Vela, Colombia, 11°57'N, 72°36'W approximately, 38-69 m; 19 ad. dd., 2 juv. dd., off Cabo de Vela, Colombia, 12°00.4'N, 72°31.9'W, TMC.

**Type locality.** Off Cabo de Vela, Colombia, 12°06.7'N, 72°19.3'W, 50-59 m. (Map ref. 8).

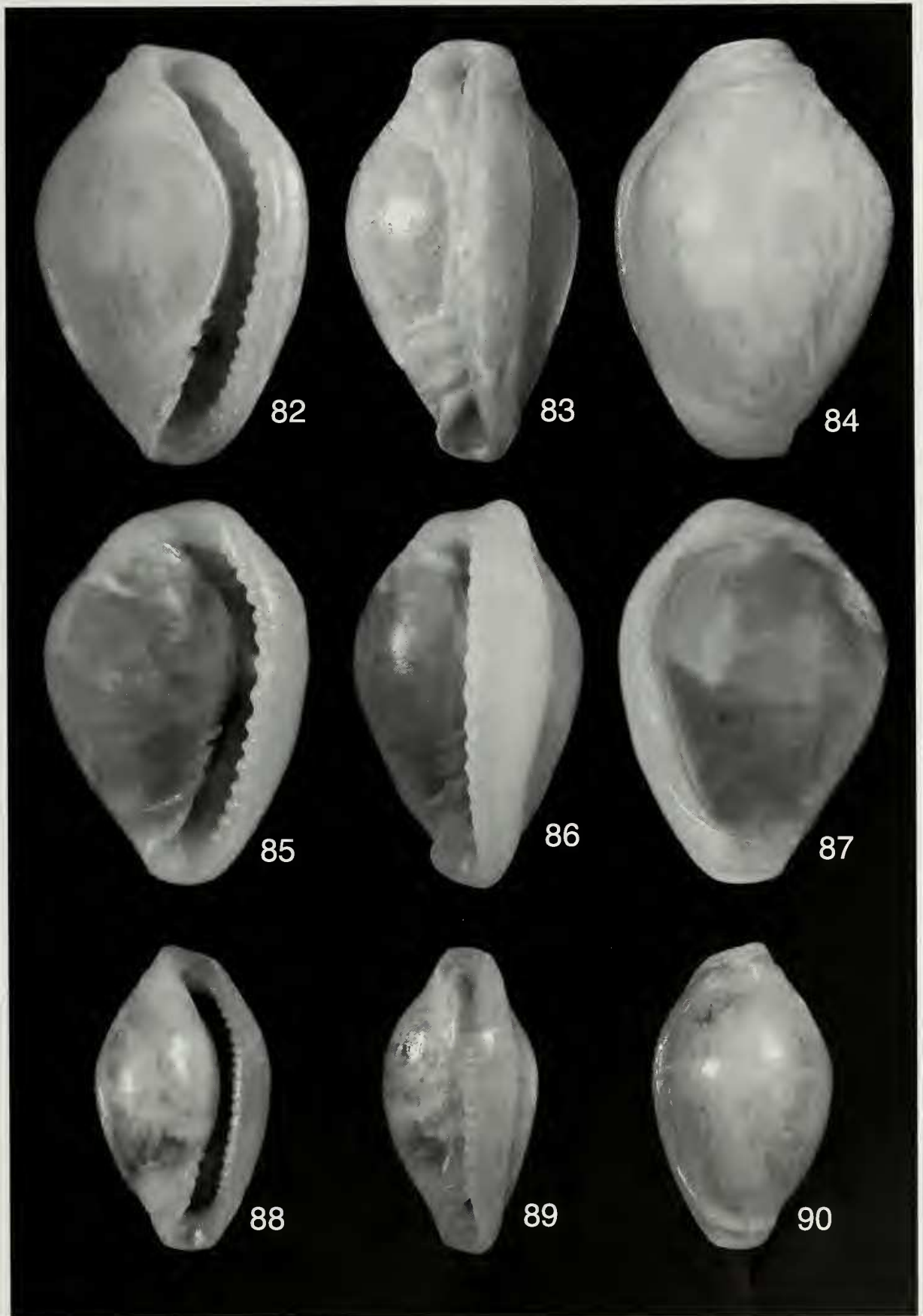
**Description.** Shell without colour, globose, very slightly biconic, very solid. Size range 1.86 x 1.40 mm to 2.02 x 1.53 mm, W:L 71-76%. Body whorl semi-transparent, with light callus wash, lightly textured. Lip gently curved, extremely wide, curls very strongly inwards. Fourteen irregular denticles completely fill inner edge, widely spaced posteriorly. In side view, lip almost straight except extreme posterior end which turns to right. External varix, very wide medially, less so posteriorly, narrow anteriorly, strongly raised on dorsum, weakens at gently curved apex, moderately strong callus with straight transverse edge extends onto dorsum. Weakening varix and dorsal callus continue around posterior canal forming short ventral ridge to merge with parietal callus ridge. Varix weakens, sweeps

**Figures 82-90**

**82-84.** *Granulina granatensis* n. sp. Holotype. Off Santa Martha, Colombia, 11°18.0'N, 74°12.2'W, 90-101 m. 3.05 x 2.02 mm, W:L 66%, MNHN 21964.

**85-87.** *Granulina tobagoensis* n. sp. Holotype. Off Tobago, to north, Trinidad and Tobago, 11°16'N, 60°49'W, 86 m. 2.79 x 2.01 mm, W:L 72%, MNHN 21983.

**88-90.** *Granulina producera* n. sp. Holotype. Off Piscadera Bay, Curaçao, 12°07.5'N, 68°58.5'W, 130 m. 2.22 x 1.30 mm, W:L 59%, MNHN 21981.



around weak siphonal canal, merges with wide anterior callus. Labial edge joins raised first columellar plication. Four plications fill approximately 45% of aperture. All plications excavated. First weak, narrow, slightly kinked and swollen medially. Second weak, widened externally, slightly kinked downwards, rather short, bifurcated distally. Third and fourth stop abruptly in aperture before excavation, both have small external lump. Parietal ridge strong, smooth, unusually remote from aperture, commences at third plication. Aperture wide at ends, narrower medially, parietal wall strongly curved. Surfaces of all callus deposits textured with minute pustules.

**Distribution.** Only known from the type locality and stations in adjoining area to 12°06.7'N, 72°19.3'W, approximately twenty miles apart.

**Remarks.** Only dead shells were collected. *Granulina pinguis* n. sp. is very solid, inflated, and unlike any other described Caribbean *Granulina*. It is closest to *G. cartagenaensis* n. sp. with which it is compared. *Granulina pinguis* averages less than 2 mm in shell length, compared with over 2.5 mm for *G. cartagenaensis*, W:L ratios are similar. Significant differences are present in the plications: in *G. cartagenaensis* they fill one third of the aperture, and the second is very long distally. In *G. pinguis* plications fill approximately 45% of the aperture and all are shorter. The most significant difference is the extremely wide, very strongly curled in lip of *G. pinguis*. These two species can be separated by any one of these features.

*Graulinia ovuliformis* d'Orbigny, 1842, should also be mentioned here as the name suggests an inflated shell shape. The original description of *G. ovuliformis* includes the statements that the shell is narrow anteriorly and wide posteriorly, and the aperture extends beyond the length of the shell, the same as the lip. These features are found in many undescribed *Granulina* spp., but are not applicable to *G. pinguis*.

**Etymology.** The name reflects the solid appearance of this species and is taken from the Latin word *pinguis* meaning gross.

***Granulina granatensis* n. sp.**

Figs 82-84, 106

**Type material.** Off Santa Martha, Colombia, 11°18.0'N, 74°12.2'W, 90-101 m.

Holotype, 3.05 x 2.02 mm, W:L 66%, MNHN 21964; paratype 1, 2.59 x 1.73 mm, W:L 67%, MNHN 21965; paratype 2, 2.55 x 1.77 mm, W:L 69%, AWC; paratype 3, 2.48 x 1.69 mm, W:L 68%, AWC; paratype 4, 2.74 x 1.79 mm, W:L 65%, TMC; paratype 5, 2.66 x 1.81 mm, W:L 68%, TMC.

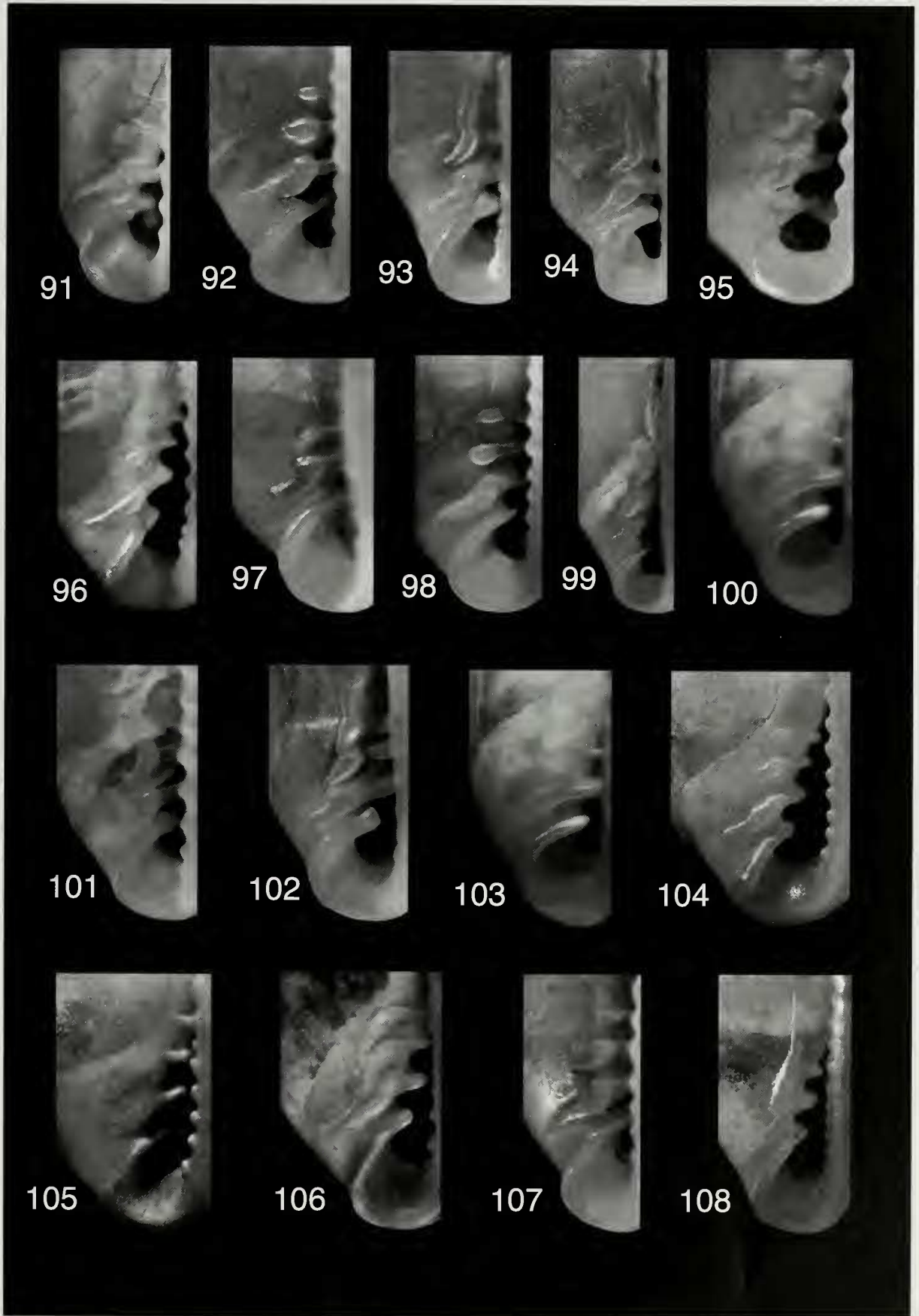
**Other material.** 7 ad. lv., 5 ad dd., 2 juv. dd., off Santa Martha, Colombia, 11° 18'N, 74°12'W, 46-99 m TMC.

**Type locality.** Off Santa Martha, Colombia, 11° 18.0'N, 74°12.2'W (Map ref. 6).

**Description.** Shell without colour, obovate, slightly produced at both ends. Size range 2.48 x 1.69 mm to 3.05 x 2.02 mm, W:L 65-69%. Body whorl semi-transparent, dorsum slightly striate, covered by light callus wash with fine texture. Lip gently curved, wide, slightly more so medially, strongly curled inwards, completely filled by nineteen denticles, widely spaced posteriorly. In side view, lip slightly convex, more so anteriorly. External varix moderately strong, dorsal edge almost straight, maintains profile, sweeps tightly around narrow posterior canal, drops down steeply as lumpy ridge, merges with parietal callus ridge. Strong secondary ridge associated with dorsal edge of varix curves completely around dorsum, slightly below apex, merges with parietal callus ridge. Varix sweeps around siphonal canal, merges with weak anterior callus. Labial edge merges with raised, very strong first columellar plication. Four strong plications fill approximately 37% of aperture. All slightly excavated. First moderately deep, narrow swelling on posterior side medially. Second sinuous, thickened, kinked downwards as it emerges, merges with anterior callus. Third with pointed distal lump pointing downwards. Fourth with substantial distal lump pointing downwards, fading, joins third distally.

**Figures 91-108**

**91.** *Granulina volcaua*, holotype, 2.67 x 1.87 mm, W:L 70%; **92.** *Granulina calla*, holotype, 2.57 x 1.75 mm, W:L 68%; **93.** *Granulina colouensis*, holotype, 1.98 x 1.31 mm, W:L 66%; **94.** *Granulina darieueensis*, holotype, 2.14 x 1.39 mm, W:L 65%; **95.** *Graulinia gayracaensis*, paratype 3, 1.64 x 1.17 mm, W:L 71%; **96.** *Granulina cartagenaensis*, holotype, 2.33 x 1.77 mm, W:L 76%; **97.** *Granulina waltergonzezi*, holotype, 1.47 x 1.16 mm, W:L 79%; **98.** *Granulina iridisa*, holotype, 2.37 x 1.66 mm, W:L 70%; **99.** *Graulinia monjesensis*, holotype, 1.74 x 1.27 mm, W:L 73%; **100.** *Granulina plagula*, holotype, 1.63 x 1.14 mm, W:L 70%; **101.** *Graulinia ovata*, holotype, 1.95 x 1.30 mm, W:L 67%; **102.** *Granulina ocella*, paratype 1, 1.56 x 1.14 mm, W:L 73%; **103.** *Granulina nivalis*, holotype, 1.62 x 1.15 mm, W:L 71%; **104.** *Granulina velaensis*, paratype 1, 2.82 x 1.94 mm, W:L 69%; **105.** *Granulina pinguis*, holotype, 2.02 x 1.53 mm, W:L 76%; **106.** *Granulina granatensis*, holotype, 3.05 x 2.02 mm, W:L 66%; **107.** *Granulina tobagoensis*, paratype 4, 2.80 x 1.97 mm, W:L 70%; **108.** *Graulinia producera*, holotype, 2.22 x 1.30 mm, W:L 59%.



Parietal ridge weak, commences above fourth plication, extends posteriorly. Aperture moderately wide, less so medially. Surfaces of all callus deposits, textured with minute pustules.

**Distribution.** Only known from the type locality.

**Remarks.** Seven live animals of *Granulina granatensis* n. sp. were collected but died before imaging, therefore, specific assessment is based solely on the shell morphology. *Granulina granatensis* is closest to *G. velaensis* with which it is compared. Holotypes of both species are mature shells, therefore, the callus deposits of each are considered to accurately represent each species. *Granulina granatensis* is a more heavily callused species than *G. velaensis* (Figs 70-72, 104). Callus deposits are particularly heavy posteriorly where a strong secondary ridge curves completely around the dorsum, slightly below the apex – absent in *G. granatensis*. Plications are deeper, angled downwards distally, the third and fourth tend to join together. *G. velaensis* has a very strong external varix with a very strong dorsal edge, but this does not result in a secondary posterior callus ridge. The third and fourth plications point straight outwards from the aperture with no tendency to merge.

**Etymology.** The name is taken from Granate Bay, close to the type locality.

***Granulina tobagoensis* n. sp.**

Figs 85-87, 107, 125-128, 133-135

**Type material.** Off Tobago, to north, Trinidad and Tobago, 11°16'N, 60°49'W, 86 m.

Holotype. 2.79 x 2.01 mm, W:L 72%, MNHN 21983; paratype 1. 2.59 x 1.83 mm, W:L 71%, MNHN 21984; paratype 2. 3.18 x 2.24 mm, W:L 70%, AWC; paratype 3. 3.38 x 2.42 mm, W:L 72%, AWC; paratype 4. 2.80 x 1.97 mm, W:L 70%, TMC; paratype 5. 3.42 x 2.46 mm, W:L 72%, TMC.

**Other material.** Approximately 500 shells, off N. W. Tobago, Trinidad and Tobago, at various stations in area around 11°16'N, 60°49'W, 73-86 m, TMC.

**Type locality.** Off N. W. Tobago, Trinidad and Tobago, 11°16'N, 60°49'W, 86 m (Map ref. 17).

**Description.** Shell without colour, weakly pyriform,

lightly textured. Size range 2.59 x 1.83 mm to 3.42 x 2.46 mm, W:L 70-72%. Body whorl semi-transparent, light callus wash, slightly striate. Lip curved, more so posteriorly, wide, widest medially, curls inwards strongly. Fifteen denticles completely fill inner edge, widely spaced posteriorly. In side view, lip slightly convex. External varix strong, wide, widest medially, dorsal edge convex, raised slightly on dorsum, sweeps around slightly flared posterior canal, forms short, strong, lumpy callus ridge ventrally, merges with parietal callus ridge. Dorsal edge of varix sweeps around posterior canal at lower level, forming strong ridge with distinct groove above, fades out ventrally. Anteriorly, varix sweeps strongly around slightly produced siphonal canal, merges with first columellar plication. Four plications fill approximately 39% of aperture, all moderately excavated, first least so. First weakest, moderately deep, narrow, swelling on posterior side medially; second with wide flat lump, kinked downwards as it emerges, long thin finger merges distally with anterior callus; third with wide lump, very short finger extending from bottom, pointing upwards slightly distally; fourth weakest with small raised lump distally. Weak parietal ridge commences at fourth plication, extends posteriorly. Aperture moderately and uniformly wide. Surfaces of all callus deposits textured with minute pustules.

**Distribution.** Only known from the type locality and adjoining north west coastal area of Tobago.

**Remarks.** *Granulina tobagoensis* n. sp. was found to be very common in the area along the north west coast of Tobago. It appears to be related to *G. calla* n. sp. and *G. volcana* n. sp., but is closest to *G. volcana* with which it is compared. The posterior half of the parietal wall of *G. tobagoensis* is considerably more convex, the posterior canal is wider and slightly flared. The plications are weaker, the second is longer, thinner, and consistently extends further over the anterior callus. The external varix is stronger and the dorsal edge stronger. These are small but consistent differences.

One specimen was collected with a live animal which died before imaging (Paratype 4, TMC). The largest *Granulina* so far recorded from the Caribbean – 3.42 mm – belongs to *G. tobagoensis* (Paratype 5, TMC).

**Etymology.** The name is taken from the type locality.

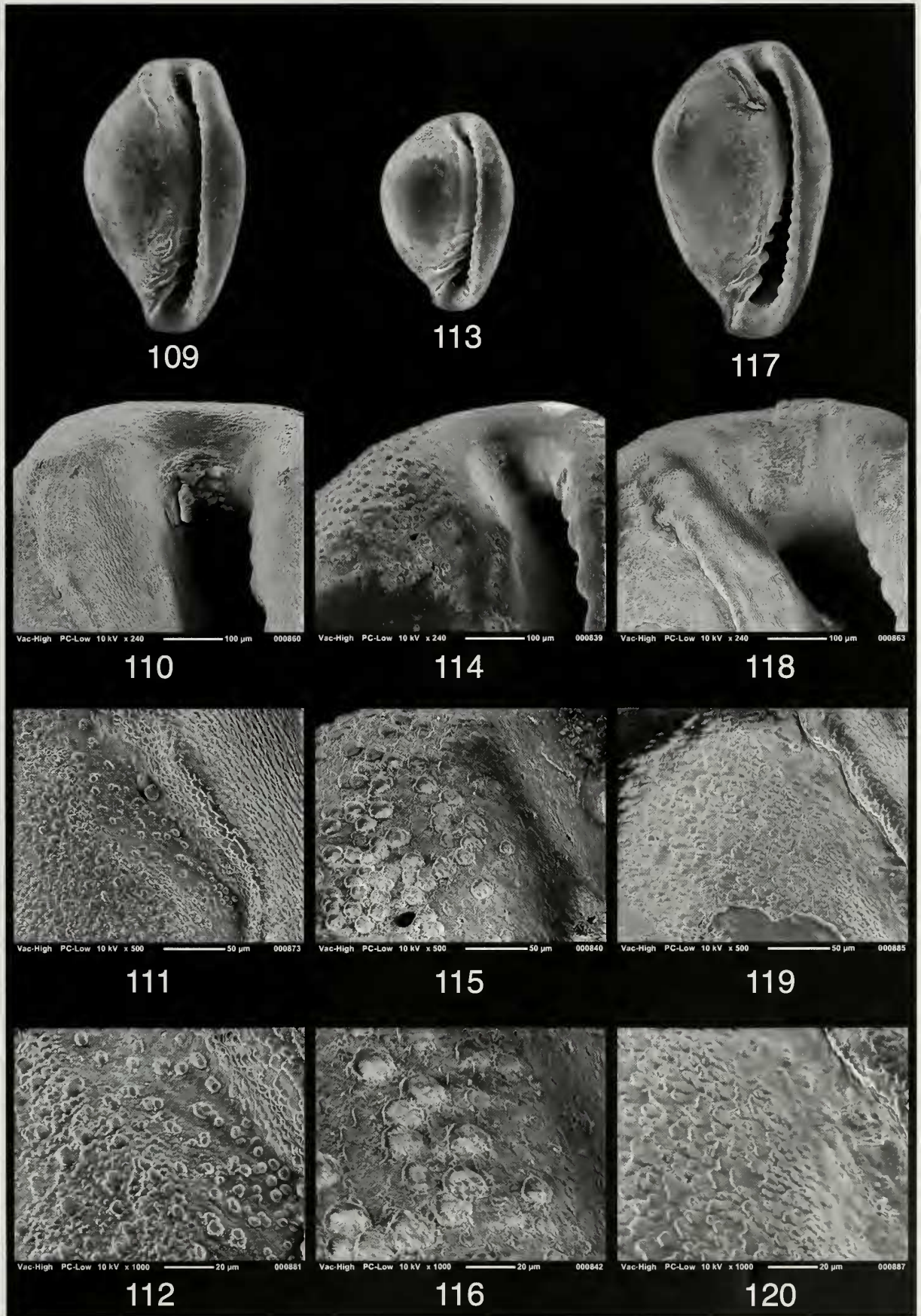
## Figures 109-120

109-120. S.E.M. images of shell surface texture.

109-112. *Granulina Colonensis* n. sp. Holotype. 1.98 x 1.31 mm, W:L 66%.

113-116. *Granulina waltergomezi* n. sp. Paratype 2. 1.43 x 1.08 mm, W:L 75%.

117-120. *Granulina darienensis* n. sp. Holotype. 2.14 x 1.39 mm, W:L 65%.



***Granulina producera* n. sp.**

Figs 88-90, 108

**Type material.** Off Piscadera Bay, Curaçao, 12°07.5'N, 68°58.5'W, 130 m.

Holotype. 2.22 x 1.30 mm, W:L 59%, MNHN 21981; paratype 1. 2.22 x 1.40 mm, W:L 63%, MNHN 21982; paratype 2. 2.23 x 1.37 mm, W:L 62%, TMC; paratype 3. 2.22 x 1.35 mm, W:L 61%, TMC.

**Type locality.** Off Piscadera Bay, Curaçao, 12°07.5'N, 68°58.5'W, 130 m (Map ref. 11).

**Description.** Shell without colour, elongate, slightly produced. Size range 2.22 x 1.30 mm to 2.23 x 1.37 mm, W:L 59-63%. Dorsum semi-transparent, somewhat striate, light callus wash, lightly textured. Lip slightly curved, mainly posterior medially, curled inwards, moderately wide, widest medially. Twenty seven denticles, strongest medially, fill inner edge. In side view, lip slightly convex. External varix wide, raised on dorsum medially, sweeps around posterior canal, flared to narrow edge. Dorsal edge of varix sweeps around posterior canal, slightly lower, as ridge, merges into parietal callus ridge. Continuing wide varix sweeps around siphonal canal, weakens, merges with first columellar plication. Anterior dorsal edge of varix continues as ridge, merges with second plication. Four weak plications fill approximately 33% of aperture, all excavated. First thin, moderately deep; second wider, tapering to point distally; third and fourth end internally. Large, flat, callus lump above second plication narrows and extends posteriorly, merges with weak parietal ridge. Aperture narrow medially, wider and slightly flared anteriorly.

**Distribution.** Only known from the type locality.

**Remarks.** *Granulina producera* n. sp. does not compare closely with any new species described herein, but is close to *G. molinai* Espinosa and Ortea, 2005, from Cuba, with which it is compared. *Granulina molinai* is represented by eight live specimens collected in Pinar, del Rio, Cuba, (Espinosa and Ortea, 2005: 38-39, Figs 306). *Granulina producera* is slightly longer at 2.22 - 2.23 mm than *G. molinai* at 1.85 - 2.0 mm, external varix is narrower

medially, dorsum smooth, whereas, *G. molinai* has substantially stronger varix and is moderately striate. Most significant difference - one which clearly separates these two species - are the very unusual, elongate denticles which project outwards from the posterior extremity of the lip of *G. molinai*, whereas denticles fade out on internal edge of the slightly flared lip in *G. producera*. There appears to be a widespread group of these elongate *Granulina* inhabiting the Caribbean as the author has in his collection several other undescribed species from widely separated locations, each only represented by one or two dead shells, in poor condition.

**Etymology.** The name is derived from the Latin verb *producere* meaning to elongate.

**ACKNOWLEDGMENTS**

The author wishes to thank Andrew Wakefield for his invaluable help during the preparation of this paper - for providing historical documents and original descriptions, for answering many questions and for his continuing encouragement; Franck Boyer for his invaluable help and guidance on many important matters, for his critical appraisal of an early draft, and for his continuing encouragement. He especially thanks Roland Houart for his support and very valuable help with technical matters relating to the writing of this article.

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**Figures 121-132**

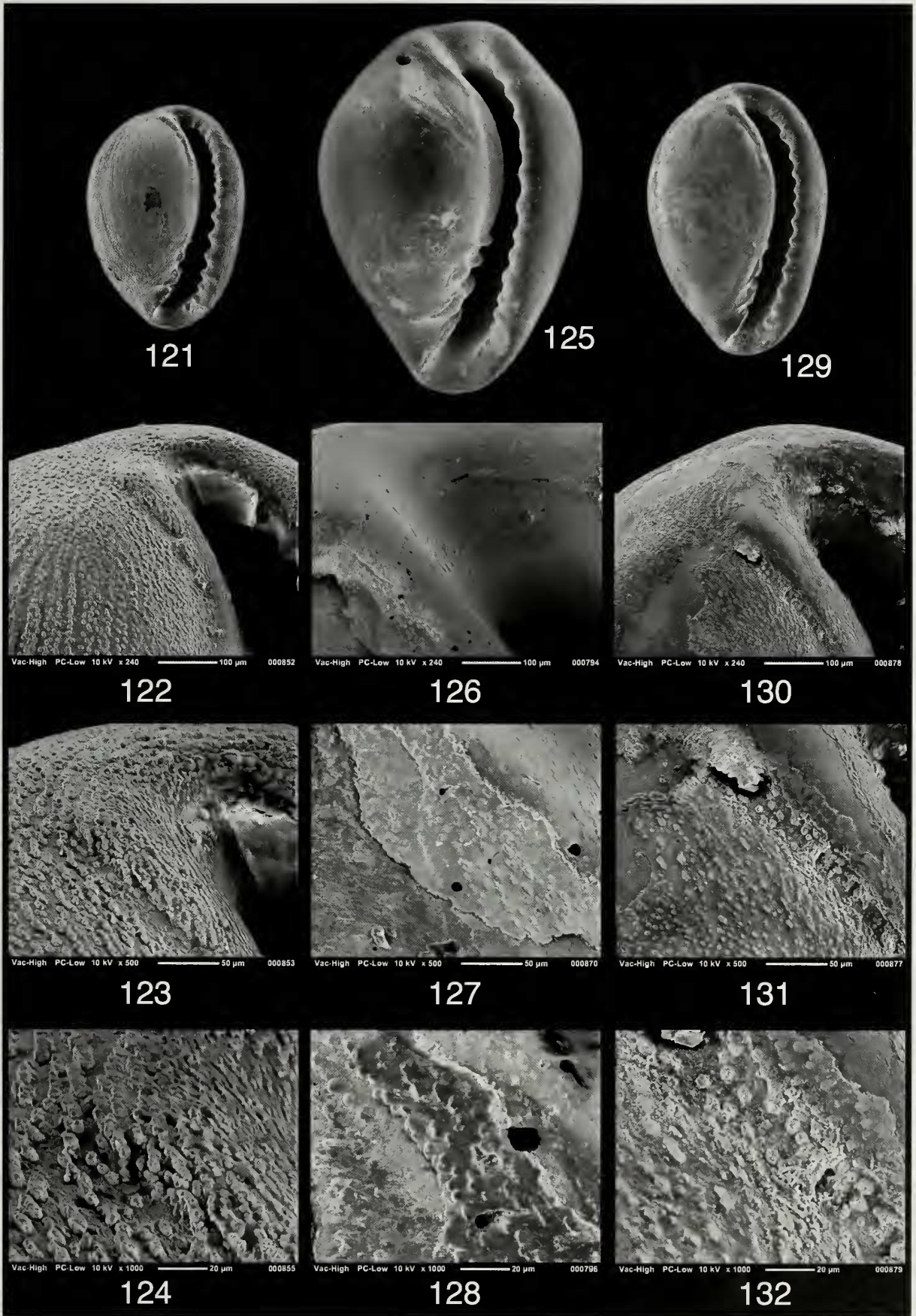
121-132. S.E.M. images of shell surface texture.

121-124. *Granulina nivalis* n. sp. Holotype. 1.62 x 1.15 mm, W:L 71%.

125-128. *Granulina tobagoensis* n. sp. Holotype. 2.79 x 2.01 mm, W:L 72%.

129-132. *Granulina ovata* n. sp. Holotype. 1.95 x 1.30 mm, W:L 67%.





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### Figures 133-141

**133-135.** *Granulina tobagoensis* n. sp. Three dead shells from type locality, with partially resorbed internal whorls and reduced columellar plications.

**133.** Adult shell, ventral view; **134.** Adult shell, dorsal view; **135.** Juvenile shell, ventral view.

**136-141.** *Granulina nivalis* n. sp. Adult specimen from type locality.

**136-138.** Light surface texture on internal surface of body whorl, close to apex; **139-141.** External, posterior surface of body whorl with partially removed, textured callus wash, exposing weak striations.

